DOCUMENT RESUME

ED 058 394 VT 014 238

TITLE The World of Manufacturing, Teacher's Guide. Industrial Arts Curriculum Project.
INSTITUTION Ohio State Univ., Columbus. Research Foundation.
SPONS AGENCY Office of Education (DHEW), Washington, D.C.
PUB DATE 71
NOTE 373p.; Fourth Edition
AVAILABLE FROM McKnight and McKnight Pub. Co., Route 66, Bloomington, Ill. 61701 ($24.00 list price)

EDRS PRICE MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS *Career Education; Concept Teaching; Curriculum Guides; *Industrial Arts; Industrial Technology; *Instructional Materials; Lesson Plans; *Manufacturing Industry; Occupational Guidance; Occupational Information; Resource Materials; Secondary Grades; *Teaching Guides
IDENTIFIERS IACP; Industrial Arts Curriculum Project; World of Manufacturing

ABSTRACT

This teacher's guide encompassing the concepts found in the world of manufacturing is designed for junior high school students to be used as a total educational package with the textbook (VT 014 240) and laboratory manual (VT 014 239). As the second part of a 2-year integrated program in which the first year concerns construction, it is designed to prepare students for enlightened citizenship and to provide educational-occupational guidance for the world of work. This program was designed to be used 45 minutes per day for 185 days, with 20 optional assignments for flexibility. Each of the 185 assignment units includes objectives, overview, suggestions for presentation and discussion, homework, and tests. Assignments cover: (1) an overview of manufacturing technology, (2) analysis of the concepts of researching, designing, and engineering as they apply to products and processes, (3) analysis of production practices, and (4) personnel policies. A list of teaching aids and special equipment, a list of equipment for students, and a list of expendable supplies are appended. The guide is in three ring binder format for ease in use. Related documents are available as VT 014 088, and VT 014 241-VT 014 244. (GEB)

THE WORLD OF Manufacturing

TEACHER'S GUIDE

DONALD G. LUX • WILLIS E. RAY, Co-Directors
Industrial Arts Curriculum Project
A. DEAN HAUENSTEIN, Assistant Director
Curriculum Development

McKNIGHT & McKNIGHT PUBLISHING COMPANY
Bloomington, Illinois

Fourth Edition

Lithographed in U.S.A.

SBN: 87345-552-5

Table of Contents

*Review of previous reading.

*Review of previous reading.

*Review of previous reading.

*Review of previous reading.

Explanation of Course Design and Instructional System

The World of Manufacturing is a comprehensive and innovative one-year junior high school course in manufacturing technology. Its instructional system is designed to prepare students for enlightened citizenship and to provide educational-occupational guidance for the world of work.

This is the second part of an integrated two-year program. The first-year course is in construction technology. The two-course sequence is designed to provide an introductory study of industrial technology. In these courses, industry is defined as that subcategory of the economic system which substantially changes the form of materials in response to man's wants for material goods and services. Technology is defined as the knowledge of techniques. Industrial arts is defined as an organized study of the knowledge of techniques used in construction and in manufacture, or industry.

COURSE DESIGN

Introduction	Analysis		Synthesis
Overview of Manufacturing Technology	MANAGEMENT AND PERSONNEL Researching, Designing, and Engineering: Products and Processes	PRODUCTION AND PERSONNEL Processing and Producing Components, Subassemblies, and Assemblies	The Manufacturing Corporation: Formation, Operation, and Liquidation
Day 1	15	77	143 — 185

This one-year course is divided into three major sections:

1. An introduction that provides a brief history of manufacturing and an overview of the major concepts of the course;
2. An analysis of the managed-personnel-production system of manufacture; and
3. A synthesis of manufacturing practices applied to the corporation.

The introduction to the managed-personnel-production system begins with an overview of manufacturing technology (15 assignments). Then an analysis of the concepts of researching, designing, and engineering are cycled as they apply to products and processes (62 assignments). This is followed by an analysis of production practices (66 assignments). Personnel practices are interspersed throughout the assignments wherever they are most relevant. The analysis section will provide a basic understanding of the common system of manufacture for any product, whether it is a textile, metal, plastic, wood, chemical, leather, food, electrical, rubber, printed, or petroleum product, to name a few.

Characteristics

The World of Manufacturing is a total educational package. It provides the teacher with all that is needed to operate the program. Included in the package are: textbooks, Laboratory Manuals, a Teacher's Guide, achievement tests, course objectives, daily behavioral objectives, time schedules, presentations, demonstrations, discussion questions, procedures for laboratory management, safety precautions, lists of equipment, tools, expendable materials, special materials, and visual aids and devices.

The analysis of the managed-personnel-production system is characterized by a carefully structured body of knowledge which is presented in the textbook. The textbook is organized and structured to provide the student with a mental image of manufacturing concepts. A companion Laboratory Manual provides the student with activities which reinforce each concept.

All learning experiences are designed to bring about carefully delineated behavioral changes in the cognitive, affective, and psychomotor domains. These behavioral changes which can be expected to result from reading, discussion, and laboratory performance are listed for each day of the course.

Textbook

The textbook was written by experts in the field of manufacturing and was field-tested and age-graded by editors and junior high school teachers. It is organized and illustrated to provide the student with a conceptual framework for understanding manufacturing technology. A conceptual model appears at the end of each reading to help the student understand the context and relationships of concepts he has read about. Thought-provoking review questions and listings of important words also are placed at the end of each reading.

All readings carry a number and should be read in sequence according to assignments listed in the Teacher's Guide table of contents. On the average, readings are assigned two or three times each week. The textbooks may be kept at home and are not required in the daily laboratory activity.

Laboratory Manual

The Laboratory Manual was developed and field-tested by professional educators. All activities are designed to reinforce the concepts students have read about. The Laboratory Manuals are kept in the laboratory and should be used with each activity.

Activities are keyed with a number which corresponds to the sequence in which they occur. A letter beside an activity number indicates one of a series of activities related to a manufacturing concept.

Teacher's Guide

The key to the operation of this program is the Teacher's Guide. The following focuses on the features of this guide.

A. **Table of Contents**

Upon examining the Table of Contents, you will find terms such as *optional, review,* and *test,* as well as reading titles. Since school years vary throughout the nation, 20 optional assignments have been built into the program. This makes it possible to fit the program to your particular school year. The number of days' difference between your school year and 185 days will determine how many optional days should be deleted from the course. Optional days are normally extensions of a preceding assignment or reviews and are desirable learning experiences, but they are not essential to gaining minimum coverage of the subject matter.

B. **Objectives**

Statements of behavioral objectives appear each day, related to the text, discussion, and laboratory activity. These statements of behavioral objectives are intended to suggest the evidences of learning on the part of the student. The instructional system for this program has been designed to facilitate the achievement of the daily behavioral objectives which build toward the course objectives.

C. **Time Schedule**

Each 45-minute class period is divided into time allotments for the scheduled events. The time allotments are guides for pacing the coverage of the day's events.

DAILY SCHEDULE OF OPERATIONS

Homework		In-Class Learning Experiences (45 min.)			
Reading	Review	Overview	Presentation or Demonstration	Discussion	Laboratory Activity

D. **Equipment and Supplies**

The equipment and supplies are listed for each teacher demonstration and student laboratory activity. Where equipment and supplies are listed "per teacher," the teacher needs that quantity for any number of classes. "Per class" means that each class needs that quantity. The teacher should multiply the number of classes he teaches by that number to get the total required. The quantity requirements are based on a class of 25 students. If a teacher has fewer or more than this per class, he must reduce or increase the quantity proportionally. Frequently, a set or quantity of equipment and supplies is specified for a group of five students. To determine the quantity needed for a class, divide the number of students in the class by five: this figure is the number of sets of materials you need to supply for that class. The number of students per group can be increased to six or decreased to four to accommodate a particular class size. For maximum student participation, groups of four rather than six are recommended. Composite lists of all equipment and supplies for the course are found in the Appendices.

Assignments 61 to 81 are open-ended in terms of a product to be manufactured. The teacher should select simple products that could be mass-produced during this section of the course. Thought should be given to utilizing the specialized equipment in your laboratory. Part of your program budget should be held until the materials have been selected for this section.

E. **Overview**

The overview provides a general digest of the important points of the text, what the teacher will talk about or demonstrate, what students should be able to answer in the discussion period, and what the students will do in the laboratory activity. The overview is written so that it can be presented verbatim to the students, or it can be paraphrased. The overview sets the learner's frame to reference for the day's learning experiences.

F. **Presentation and Demonstration**

This section provides the teacher with salient points to be expanded or clarified. A presentation is an expansion of some topic in the text and usually is closely related to what students will do in the laboratory activity. Many presentations and demonstrations include the use of visual aids such as transparencies or filmstrips.

G. **Discussion**

The purpose of the discussion period is to provide teachers with feedback evidence that information is being understood by the student. Therefore, questions are provided to be asked of students to determine the extent of understanding. Answers are provided to accommodate corrective feedback and reinforcement. The questions can be presented verbatim or paraphrased.

H. **Laboratory Activity**

This section provides the teacher with the management procedures necessary to direct the activity. Included are class arrangements, precautions, and suggestions for facilitating laboratory organization and operation.

I. **Safety**

Safety precautions are included in assignments where there may be dangerous conditions above and beyond normal laboratory operation. The teacher must use his own discretion in applying local safety regulations such as the wearing of safety goggles, fire drill procedures, use of equipment, and handling of materials. Safety precautions are noted in the Laboratory Manual where applicable.

J. **Laboratory Manual Answers**

The answers listed in this section correspond to the questions and problems requiring answers in the Laboratory Manual.

K. **Tests**

Five tests are scheduled in the first semester and five in the second semester. Each test follows a review day. The tests consist of approximately 35 multiple-choice questions. Approximately 35 minutes are allotted for each test, the remainder of the time being spent on reviewing the test questions as corrective feedback.

Program Objectives

A study of industrial arts serves these purposes:

1. Enables students to understand the concepts, principles, generalizations, problems, and strategies of industrial technology.
2. Encourages an interest in and an appreciation for industry as that element of the economic system that provides industrial material goods for the satisfaction of human wants.
3. Provides knowledge and skills that will be useful in life situations of occupational, recreational, consumer, and socio-cultural significance.

Course Objectives

This course will enable the student to do the following:

1. Place manufacturing technology in the broader context of industrial technology and all of technology.
2. Be aware of the history, present character, and future of the manufacturing phase of industry.
3. Appreciate, understand, and perform selected management practices in planning, organizing, and controlling as they relate to manufacturing production systems.
4. Appreciate, understand, and perform selected personnel practices of hiring, training, working, advancing, and retiring as they relate to a managed production system in manufacturing.
5. Appreciate, understand, and perform selected production practices in preprocessing, processing, and postprocessing or servicing as they apply to manufacturing production systems.
6. Appreciate and understand the interrelationships within and between management, personnel, and production practices.
7. Appreciate and have some understanding of manufactured products and the tools and materials utilized in their manufacture.
8. Utilize the knowledge and skills of manufacturing management and production to investigate factors involved in the manufacture of representative products.
9. Develop an awareness of vocations in manufacturing industries.
10. Develop responsible and safe work attitudes and the ability to function as a member of a group.
11. Develop an awareness of self-realization and generate self-activating behaviors.

ASSIGNMENT 1

Optional

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given an orientation by the teacher, state the teacher's name, the course title, the room number, the weekly class schedule, seating assignments, and locker assignments.

Time Schedule

10	Presentation
10-35	Discussion

Presentation (10)

1. If the first day is a full period, proceed to Assignment 3. In this event, you will not have used two (2) optional days which are provided to account for the possibility of one or two shortened periods at the beginning of the school year. If you do not use these optional days, they may be used at your discretion later in the year.
2. If the first day is not a full period, you may use the shortened period to introduce yourself and to *present the course title*, the *room number*, and the *weekly class schedule, make seating assignments, assign lockers*, etc.

Discussion (35)

The balance of the time may be used for administrative matters and discussion.

Homework

None

ASSIGNMENT 2

Optional

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given an orientation to classroom procedures and policies:
   a. State the procedures in routine and emergency situations, as a fire drill, etc.
   b. Complete forms or provide information required for the class or school.
   c. State seating arrangements and locker assignments.

Time Schedule

10	Presentation
10-35	Discussion

Presentation (10)

1. If this second day is a full period, proceed to Assignment 3. In this event, you will have saved an optional day which may be used at your discretion later in the course.
2. If the second day is not a full period, you may use the shortened period to describe routine and emergency procedures such as those to be followed in the event of tardiness or of fire.

Discussion (10-35)

1. Additional time may be used for administrative matters and discussion.

Homework

None

ASSIGNMENT 3

Introduction

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the course organization and content:
   a. Name some of the student activities in the course.
   b. Name the two books they will use in the course and explain how, when, and where each is to be used.
   c. State how a *concept* is studied in this class.
   d. State what the homework assignment *is* and *how* and *when* it should be done.

Laboratory Activity

2. Given a class section of junior high school manufacturing students, organize and structure the class section into groups which contain *a foreman, a timekeeper, a recorder, an equipment supervisor,* and *a safety supervisor.*
3. Given a set of Laboratory Manuals, code the materials for efficient distribution.

Time Schedule

10 Administrative Matters
10 Material Distribution
15 Presentation
10 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

10 felt markers, fine point (2 each of 5 colors)
1 projector w/screen

Supplies (Class)

25 ea. Textbooks and Laboratory Manuals
1 Teacher's Class Organization Chart (one per school) No. 3
1 set Filmstrip No. 3, *The World of Manufacturing* (80 frames)

Administrative Matters (10)

If either or both of Assignments 1 and 2 were not used, you will need to use part of this period to make announcements and to dispose of administrative matters. If there are no administrative details, you will have additional time to introduce the course organization and content.

Material Distribution (10)

1. Distribute the textbooks and Laboratory Manuals, and explain how they are used. For example, in studying a concept the student reads about it, answers some review questions and problems, and then performs some laboratory activities which further illustrate and explain the concept.
2. Explain that the textbooks are mainly used outside of class, and that the Laboratory Manuals are mainly used during class time and are stored in the laboratory.
3. Explain that if the homework is not completed on schedule, the students will not be fully prepared to do the related laboratory activities.

Note

If a student leaves during the year or sells his Laboratory Manual to another student, a gummed label can be placed over the former student's name and the new name recorded.

Presentation (15)

Today's presentation introduces the course. It describes representative student activities. In this course on manufacturing technology you will study management, personnel, and production as parts of manufacturing. Today I will show you a filmstrip that describes some of the laboratory activities in the course.

Introduction to the World of Manufacturing

Script for Filmstrip No. 3 — 80 Frames

Frame No.

Focus pattern.

1. *The World of Manufacturing.* This filmstrip presents a sampling of activities for the year. The first year, "The World of Construction," together with this

second year, "The World of Manufacturing," provides you with the knowledge about the *technology of the man-made world.*

2. The teaching-learning system described in this filmstrip has been developed by the Industrial Arts Curriculum Project. The Industrial Arts Curriculum Project was an innovative curriculum development effort conducted by The Ohio State University in cooperation with the University of Illinois and many other colleges and secondary school systems. The Project has realized its principal support from the United States Office of Education and was headquartered at The Ohio State University, Columbus, Ohio. McKnight & McKnight Publishing Company in Bloomington, Illinois, was selected as the official publisher.
3. The term *technology* in this course means the *science of efficient action.* Manufacturing has three major technologies: (1) efficient *management* practices, (2) efficient *production* practices, and (3) efficient *personnel* practices. These three technologies — in a manufacturing system — *produce all of our manufactured goods.* As students you will learn about these three major technologies. You will use your own textbook, Laboratory Manual, and many manufacturing tools.
4. You will simulate how early man produced products from clay. *Each man was responsible for making products from start to finish.*
5. Here students are shown making a coat hanger employing the use of tooling in a managed production system. Prior to this exercise each of you will custom-make a coat hanger. From this, you can realize the increased productivity, quality, and savings in time that is provided through organization and specialization.
6. Good *management* practices include *planning, organizing,* and *controlling* personnel as well as materials and techniques. A class *organization chart* designates individuals for specific *responsibilities.*
7. You will be introduced to research as an important element in product design and engineering. You will make several prototype rocket airframe designs. Here spiral wrapping is employed. Experiments with these airframes will determine the best design.
8. Nose cones and motor mounts are designed, produced and installed. Tail fins are designed and engineered to keep the center of pressure behind the center of gravity. The fins are produced and assembled.
9. Parachutes are manufactured and installed, the fuel cartridge inserted, and BLAST OFF! Away she goes for a perfect flight.
10. For the next 20 days, you will learn about "product research and development." You will perform practices of researching, designing, and engineering products. A prototype Land Speed Record Assault Vehicle will be the *representative product* to be developed.

    The next 128 days of study are devoted to readings and activities which ANALYZE the management, personnel, and production practices which are required in any manufacturing system.
11. Here data about the speed records of popular racing vehicles are *retrieved* and *summarized.*
12. Different types of bearings are installed in vehicles. Bearing efficiency is determined by the vehicle which travels the greatest distance in this *experiment.* Thus, the best bearing material is determined for use in the racers to be produced.
13. With specific physical limitations imposed, you will learn to create *alternate design solutions* for a product. This is done by making *thumbnail sketches* — then *rough sketches* — and finally *refined sketches.*
14. Rough sketches of vehicle designs are drawn. From these rough sketches, *one solution* is selected and *a refined sketch is drawn.*
15. Full scale *working drawings are drawn* and each view is cut out and pasted to styrofoam material. These cutouts serve as templates to saw out a three-dimensional model known as a *soft mock-up.*
16. The *soft mock-up* is further *refined* to appear as a finished product and is called an *appearance mock-up.* Here a student proudly displays his creation.
17. You will learn what it means to *engineer a product.* The ratio of thrust and weight is used to engineer the vehicle to perform at a desired speed. Here a speed curve is developed from the results of *testing* the *weights* and *thrusts* of various vehicles. Thus, if you want

your vehicle to go faster, you must modify the weight.

18. After the engineering requirements are completed, *working drawings are made* and the body of the vehicle is *cut to rough shape* on the bandsaw. Here the shape is further refined using different hand tools.
19. Bearings and wheels are fitted and installed and all finishing touches are completed to produce a *finished prototype.* You will also do some *technical writing and illustrating* by developing a service manual for the Land Speed Record Assault Vehicle. It includes a guarantee, operating instructions, maintenance procedures, illustration, and a parts list.
20. Shown here are a variety of vehicles which have been produced by students.
21. You will have an *achievement test* about every three weeks to evaluate your progress. These tests consist of 35 multiple-choice questions based upon the textbook, laboratory activities, and discussions.
22. "Process Research and Development." Previously, emphasis was placed upon *product* R & D. The next 20 days emphasize *process* R & D. You will be involved in researching, designing, and engineering the processes necessary to produce a product such as salt and pepper shakers.
23. After *ideas are recorded* by way of refined sketches and mock-ups, the *ideas are presented* to the management *for approval.* Upon approval, a Design Release Form is completed and working drawings are developed.
24. In production planning you will *compare various production techniques,* using both hand tool and machine operations, *to determine process efficiency.* Both time and accuracy help determine the most efficient process.
25. After you establish the most efficient process for making components, you will be making *flowcharts.* To do this you will be analyzing production processes and recording the various operations, using symbols currently used by industrial and manufacturing engineers.
26. You will also *design and engineer* our *laboratory* to permit a smooth *flow of materials for production.* Some of you will *submit bids* for obtaining the necessary materials and equipment. You will learn about *occupations* and *employment opportunities* in manufacturing by utilizing the classified ads in local newspapers.
27. *Automated materials handling* is studied. We will develop and install a conveyor belt system in the laboratory. *Tooling-up* for production is completed by meshing the materials handling system to the other production equipment.
28. Components are produced at the many stations along the line. Finally the products are finished, *packaged* and made ready *for distribution.*
29. We will learn how computers are used for *processing data* or information for inventory control, accounting, production processing, and a host of other jobs. You will learn how to enter alphanumeric data on a Port-A-Punch card.
30. Everyone will *make a basic computer program* and check a printout of the data he recorded on his Port-A-Punch card.
31. You will do some research and development by researching, designing, engineering, and tooling up for a selected product. You will develop the necessary processes to manufacture a product such as a psychedelic light, electronic alarm, or kite.
32. The next series of study units includes *both product and process* R & D. In this unit a consumer survey will be conducted for a product of your choice (*a device,* for example). A variety of product designs are considered. Management makes a decision on which design your plant will produce.
33. *Full scale multiview drawings* are made from which *paste-ups* and eventually appearance *mock-ups* are made. The appearance mock-up is quite often used in conducting a *consumer survey.*
34. Once the prototype is completed and design and drawing corrections are made, engineers *plan for production* by determining the *best procedure for doing each operation.* From an analysis of these processes, a *process flowchart* is developed as shown by this student working in his Laboratory Manual. Next the plant layout will be planned for and *production* and *quality control systems* will be established.
35. After tooling-up for production is completed, you will begin *fabricating* parts

for the product. Stock is sheared to size and corners removed using templates for accuracy.

36. Hole locations are marked and holes are either punched or drilled.
37. Many industrial operations are performed to manufacture the product *components*. They are then *assembled to make complete units*. Here final adjustments are made before the *final inspection*.
38. Throughout the course *personnel practices* are considered as they logically integrate with other activities. The personnel practices considered are *hiring, training, working, advancing,* and *retiring*. Some of these have already been considered. Others will follow.
39. You will learn how to make job applications and interview for a job. You will learn that *employment* and *advancement opportunities* are quite often dependent upon qualities of judgment and dexterity. You will take part in a proficiency examination to *qualify for advancement* as the students are doing here.
40. Personnel technology includes the provision for good working relations between management and labor. Here a *collective bargaining* session is role-played to establish agreement on certain working conditions.
41. The last 11 days of the first semester are devoted to the study of *selected basic industries*. You will read about and engage in interesting activities to learn how *primary metals, petroleum, textiles,* and *chemicals* are produced.
42. After learning about major elements of management and personnel technology and how *raw materials are converted into standard stock,* we will then consider how *standard stock is converted into components and how these are combined into subassemblies and final assemblies*. Note the three major sections of the chart. The next few slides we will emphasize FORMING operations in manufacturing. The major forming processes are: *casting or molding, compressing or stretching*, and *conditioning*.
43. Here FORMING by STRETCHING is shown by using a draw die to *change the shape of the material.*
44. We will learn that material can be given shape by using *permanent molds*. As an example, you will be *mixing* and *conditioning* materials and CASTING in a permanent mold to produce concrete bricks.
45. CASTING is also done in *one-shot molds*. Here a pour is made for five mallet heads. The mold will be destroyed to obtain the cast objects.
46. We will study FORMING by STRETCHING. You will vacuum form an object using thermoplastic materials. The product might become a badge.
47. In other activities we will FORM by CASTING plastic handles for screwdrivers using standard glass test tubes as permanent molds. CHEMICAL CONDITIONING is emphasized as the process whereby the cast handle solidifies. Along with these activities a screwdriver blade is forged and heat treated and other processes are completed to emphasize the several *forming* concepts.
48. Next, we will study and perform those processes used on standard stock to SEPARATE in the process of making components. These include *shearing, chip removing* and *other processes.*
49. CHEMICAL SEPARATING is one of four categories studied under "Other Processes" which are classified as nontraditional techniques. You will use a chemical to etch a design in an anodized and dyed aluminum tag. The tag may be used on a key chain, necklace, or for some other purpose. We will also etch a design in glass.
50. The concepts of SEPARATING by SHEARING are studied as a patch is made from contact vinyl material. The student in the left foreground is using a die cutting device for shearing the patch while the girl makes a design in stencil by SHEARING with an X-acto® knife. The concept of COATING is shown by screening the lettering on the patch.
51. Here the concept of SEPARATING by CHIP REMOVING is shown as students use multipoint devices such as saws, drills, and abrasive paper to make house signs.
52. These house markers are now completed by applying numerals and a finish. Both practices are forms of *combining.*
53. We will also learn about SEPARATING by THERMAL EROSION. An Electrical Discharge Machine (EDM) is used

to erode a hex-shaped hole through a piece of sheet aluminum. This is one of the latest advancements in industrial processes.

54. You will use INDUCED FRACTURE separating to cut a glass bottle into parts.
55. Parts of a mallet, the head of which was cast earlier, are processed as holes are drilled in both the head and the tips. Here the tip of a mallet is drilled, separating material by CHIP REMOVING using a multipoint tool, a twist drill. Previous to this, the tips were cut to length using another multiedge tool, the saw.
56. We have seen some concepts of COMBINING. Later activities will show the various techniques used to combine components into subassemblies and final assemblies. Among these are *mixing, coating, bonding,* and *mechanical fastening.*
57. The tips of the mallet are attached to the head by a threaded rod, a mechanical fastener.
58. Finally, the head will be combined with the handle, using a MECHANICAL FASTENER such as a wedge or corrugated fastener. Other combining practices are involved by wrapping and dipping the cushion grip on the handle.
59. COMBINING is also accomplished by MIXING or COMPOUNDING. Here two liquids must be measured and stirred to permit a chemical reaction to take place. In this activity you will be making a flexible polyurethane sponge.
60. You will be making a utility box to review many of the processes under the concept of FORMING, SEPARATING, and COMBINING. The top of the box takes shape as it is formed by STRETCHING on the box and pan brake.
61. Another type of mechanical fastener, the pop rivet, is used here to combine components as the flexible hinge is attached. The handle on the utility box is BONDED by FUSION as several pieces of plexiglas are fastened using ethylene-dichloride.
62. You will learn how components and subassemblies are combined by using a *continuous assembly process* to complete these electrical sockets.
63. Servicing manufactured products includes *installing, maintaining, repairing,* and *altering.* Here you will learn about occupations in the service areas and learn how to use a maintenance manual to troubleshoot an electrical circuit.
64. **The Manufacturing Corporation**
In the last 42 days of the course we will *set up, operate* and *liquidate* a manufacturing corporation. In this unit the "business" side of industry is studied in greater detail to manufacture quality high-intensity lamps.
65. **Forming the Corporation**
The major steps involved in forming a corporation will be discussed.
66. After we obtain financial support, the corporation is formed and a product or products for manufacture are determined. Personnel needs must be determined to operate the enterprise.
67. A market survey is conducted to determine the "Sales Forecast." We will poll each other to obtain public opinion about several lamp designs.
68. *Prior to determining the cost of the product,* drawings and prototypes must be completed. *Profits* must be *estimated* and *records* must be *kept* by our business organization. You will learn that certain fixed and material costs exist and that a certain margin of profit must be maintained if any corporation is to remain solvent. From a break-even chart we can determine what the retail price per lamp should be and how many lamps need to be sold before our company begins to make a profit.
69. To insure efficiency in production, all processes for making each component must be charted. The steps for making all the lamp parts are shown on a production flowchart. We will learn how to interpret a flowchart and realize its importance in planning production for complex products.
70. Prior to production, all tooling must be developed and readied for use at each production station at the right moment. This activity shows students fabricating a drill fixture for making a component.
71. Before production begins, *production and quality control systems must be established* so material will flow through the plant smoothly and quality products will be manufactured. Here the lamp base bottoms are formed while an inspector checks the quality of these products.

72. A bending jig is used so that the bends on the end of the lamp stem will be uniform and will provide *interchangeable parts.*
73. As components are completed, they are *combined into subassemblies* and finally into *final assemblies,* here in the form of high-intensity lamps.
74. Each lamp must undergo a *final inspection.* If it is approved, a formal approval sticker is attached. If rejected, it is rerouted for servicing.
75. Most quality products are furnished with a Service Manual. Here we see students completing the final step in making their manual as the signature and covers are collated, trimmed, and stapled.
76. Each product is *packaged* for protection and identification. You will be just as proud as these students to display your completed lamps as they are made ready for distribution.
77. We will study the steps necessary for "Going Out Of Business." One step in the liquidating process is the accounting of all assets and liabilities to determine the total equity of the corporation. Shown here is a stockholder receiving his share of the assets for the exchange of his original stock certificates.
78. Included in the second semester is a "Study of Selected End Products" which include the Telephone, Rubber Products, Printed Products, and Basic Machine Tools. Only a few activities will be shown in the frames which follow.
79. You will learn that rubber products are produced by various processes. This activity shows balloons being made by first dipping a mold in coagulant, then in latex, and finally curing by heat.
80. In "The Study of Printed Products" you will learn about the major groups of printed materials and the four basic types of printing processes. You will be making relief stamps using innertube stock. These stamps are used to relief-print pages for personal note pads. This concludes a brief look at some of the activities in "The World of Manufacturing."

Laboratory Activity (10)

The students are to organize into standard groups and color-code their Laboratory Manuals.

1. Select a color-coded, fine-point marking pen for each class period. Example: Period 1 — red, Period 2 — green, etc.
2. Divide the class into groups of five students, and assign each group a number.
3. Assign each group a workbench.
4. Have each group select a foreman, equipment supervisor, timekeeper, recorder, and safety supervisor. (Have one student be both timekeeper and recorder if you have a group of four students. If you have six students per group, one can be a standby, in case someone is absent.) The duties for each of these people are as follows:

   Foreman: Supervises the work assignments and quality of work for each group.

   Timekeeper: Tells the group when to clean up and how much time is allotted to different jobs.

   Recorder: Reports absent or tardy group members to the teacher each day.

   Equipment Supervisor: Distributes, collects, and stores all Laboratory Manuals and other materials as directed by the teacher.

   Safety Supervisor: Observes work habits of members of the group. Warns anyone who does not follow good safety practices. Reports to the foreman if safety rules are not followed.
5. Have each recorder place the names of his group on your class organization chart. (Chart can be mounted on $\frac{1}{4}''$ plywood for reinforcement.)
6. Give fine-point marking pens of the proper color to the equipment supervisors.
7. Explain to the foremen how to number the Laboratory Manuals and how to place the $\frac{1}{8}''$ wide class color-code stripe under the group number. See Fig. 3-1. Be sure

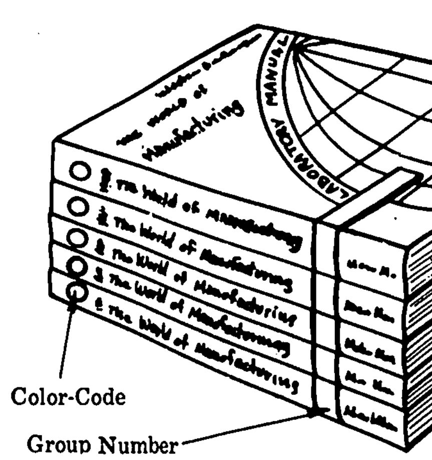


Fig. 3-1. Code for Laboratory Manuals

that foremen know their group number.

8. Have each student write his name on the front cover of his Laboratory Manual.
9. Have each equipment supervisor collect and store his group's Laboratory Manuals in an appropriate book-storage area.

Homework

Reading 1, *Man and Technology*

ASSIGNMENT 4, ACTIVITY 1
READING 1

Man and Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to man and technology:
   a. Name some leadership jobs in each of the institutions of society and name some of the responsibilities of the leaders.
   b. Describe how you benefit from the activities of each institution of society.

Discussion

2. Given the text reading and a presentation:
   a. Name the five basic social institutions of man.
   b. In their own words explain each of these institutions.

Laboratory Activity

3. Given a pound of clay, imitate the technology of primitive man by hand-forming a simple container for water.

Time Schedule

5 Overview
10 Presentation
5 Discussion
5 Demonstration
20 Laboratory Activity

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 container for water
1 plastic cup
1 sponge

Supplies (Each student)

1 lb. red potter's clay

1 pc. 12" x 24" (approx.) builder's plastic sheeting

Equipment (Per class)

1 10 gal. plastic bucket with cover for clay storage

Supplies (Group of 5)

1 pkg. paper towels

Overview (5)

1. The text reading described how technology began and how it has evolved since the time of primitive man. The five social institutions were explained.
2. I will tell you more about the social institutions of man and about technology.
3. You will be asked to name these social institutions and explain them in your own words.
4. In the laboratory activity you will have the chance to work at a very old, important craft: making a container from clay.

Presentation (10)

1. Man has always used knowledge to improve his way of life. *Technology* began when man learned ways of changing or controlling his environment.
2. There are five basic *institutions* that help man live and work in society: (a) the family; (b) religion; (c) education; (d) government; and (e) economics.
3. The *family* is the most basic of all institutions of man. Early man depended heavily on cooperation among people in his family. Today the family is still a basic unit of society. In some families all the individuals are related, but any small group of people who share a home and work to help one another make up a family.
4. Men living in various parts of the world, at various times, have developed many *religions*. They were ways of trying to explain the unknown — the things that people could not understand. A belief in some superhuman power is a part of all religions. Today, man's *religion* helps him to understand himself, his purposes, and his beliefs in his God.
5. We are now (this minute) taking part in activities of the *educational* institution. All of our schools and colleges have developed because man needed to pass knowledge from one generation to the next. In this building you are receiving what is called a "formal" education. You are here because the amount of knowledge that you must learn is so great that your parents are unable to spend enough time giving it to you.
6. People live together in large groups, but individuals own property and have certain rights. Control is needed to make sure that some people do not take advantage of other people's personal property and rights. Our *government* gives us this protection. The government also does other things. For example, without our government we probably would have very few public services for our people.
7. Through the *economic* institution we produce, trade, buy, and sell to get the goods and services we want.

Discussion (5)

1. What are the five basic social institutions of man? (The family, religious, educational, governmental, and economic institutions.)
2. In your own words explain each of these institutions. (Open-ended question. See Presentation, paragraphs 3 through 7.)

Demonstration (5)

Briefly demonstrate two ways of shaping clay by hand: coil and pinch pot techniques. See Figs. 1-1 through 1-8 in your Laboratory Manual.

1. Remind students to *wedge* (knead) the clay before using it. Wedging removes the air bubbles and gives the clay an even consistency.
2. Water can be added during the wedging process if the clay is too dry. If the clay is too wet, water can be removed by wedging the clay over a blotter or some other moisture-absorbing surface. See Fig. 1-4 in your Laboratory Manual.

Laboratory Activity (20)

The purpose of this activity is *to demonstrate the technology of early man in changing the form of materials to satisfy his wants.*

1. Divide the class into groups of five.
2. Have an equipment supervisor in each group obtain and distribute the required supplies and equipment.
3. Explain the task: *Each student* is to create a vessel to contain about one cup

of water. The only restriction is that *each student* must use only the clay and his hands, as primitive man would have done. Remind the students that clay is a messy material and care should be used to keep the laboratory equipment and their own clothing clean.

4. Students are to follow the directions in the Laboratory Manual.
5. Before the end of the period, give students the opportunity to compare their handiwork.
6. Have students return the clay to the storage container and clean the work area thoroughly.

Safety Precautions

1. Keep the working area clean.
2. Never throw clay or any other material around the laboratory.

Homework

Reading 2, *The Evolution of Manufacturing*

Note

1. If a substitute clay product is desired for ACTIVITY 2, make provisions for special tools (clay cutter) and materials if needed.
2. Make arrangements for the manufacture of coat hangers for the next two days.

The Evolution of Manufacturing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about the evolution of manufacturing:
   a. Imagine that wheels, printing presses and ways of purifying water disappeared completely. State how your life would change.
   b. Identify what new goods or new ways of producing goods would help people most.

Discussion

2. Given the text reading and presentation:
   a. Name some of man's earliest kinds of skill and knowledge.
   b. State where the first permanent societies developed, what kinds of knowledge developed there, and which part of Europe first learned advanced technological skills.
   c. Explain in their own words the Renaissance and the Industrial Revolution.

Laboratory Activity

3. Given clay and their personal inventiveness, imitate an early type of manufacture by:
   a. Choosing a clay product to produce.
   b. Choosing a production process.
   c. Organizing so that each worker has a specialized production task.
   d. Manufacturing the product.

Time Schedule

5 Overview
10 Presentation
10 Discussion
20 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 rolling pin *or* 2″ dia. pipe
1 bench knife
1 modeling tool (clay)

Equipment (Class)

1 10 gal. plastic bucket with cover for clay storage

Supplies (Group of 5)

2.5 lbs. potters' clay (Check moisture content before the first demonstration.)
1 plastic dropcloth *or* oilcloth for covering entire bench top, 6′ x 8′
rags or paper towels
1 can for water
1 sponge
5 tongue depressors

Overview (5)

1. You read how manufacturing has changed from hand-tool work to production by machines powered by water, steam, or electricity.
2. I will tell you more about the development of manufacturing through the ages.
3. We will discuss the growth of technology, and you will be asked some general questions about its development.
4. In the laboratory activity each student will specialize in one task; together you will produce kiln-ready clay tiles.

Presentation (10)

1. As you learn more and more about *how* to do something, the chance of doing it successfully is increased. The more you use your knowledge and skill to accomplish a task the first time, the easier it will be to accomplish the same task a second time.
2. The ways you find to do a task well, and do it efficiently, are called *technology*. Technology is the knowledge of "how to do things efficiently" to achieve what you want to achieve.
3. Through the ages men have developed many kinds of knowledge and skills to achieve the things they wanted. In all the lands they explored, they devised ways of using the materials of nature that were easy to get. Here are some examples:
   a. They developed hunting and fishing skills.
   b. In warm regions with good soil they developed farming skills.
   c. Wherever there was clay, they invented ways to make pots or dishes.
   d. In many regions of the world they raised herds or flocks of animals such as goats and sheep. Ways were devised to use the wool, the leather, and the milk from these herds.
   e. They devised a way to get pure metal by heating ore — rocks that contain some of the metal.
4. In six regions of the world permanent societies evolved. Two were in the continent we call Africa, two were in Asia, and two were in the Americas. In all these societies people devised skillful, efficient ways to put up buildings, weave cloth, transport goods across land or over water, and make works of art or jewelry. A written language was developed in five of the six societies.
5. As time went on, trading became more important.
   a. The farther people traveled, the more kinds of goods they brought back.
   b. Some people began to specialize in trading. We call them *merchants*.
   c. In addition to the goods they brought back to their home cities, the merchants sometimes brought back new *technology*: the knowledge of how to do or make something.
6. Technology finally spread from Africa and Asia into Europe.
   a. The Greek people imported skills and improved them very early in history.
   b. Later, the Romans developed technology further.
   c. Over a long period of time, which we call the *Middle Ages*, technology spread across Europe.
7. Starting in the 14th century, people in Europe began to study the world of nature with a new interest and curiosity. Manufacturing skills were much improved and new ones were invented. Merchants helped revive an interest in trade which in turn led to new developments in manufacturing. We call this period in history the *Renaissance*.
8. During all these centuries most goods had been manufactured with hand tools

in a house or a shed. Often the only power was a man's own muscles, although wind, moving water, and animals had been harnessed to do some work. Three changes were coming to make manufacturing much more efficient. These changes were *machinery*, *engines*, and the *factory system*. They started the *Industrial Revolution*.

9. Technology took a big step forward with the invention of several machines and the steam power to run them.
   a. Power-driven machines required new knowledge and skills.
   b. Workers became specialized machine operators. Each operation could be performed by men doing only that task.
   c. The speed and efficiency of manufacturing greatly increased. Greater quantities of products could be produced, at less cost, to satisfy people's wants. Some of the products were better than those made by hand.
10. During the early years of the factory system, working conditions were not good. Gradually laws were passed to keep young children out of the factories, shorten working hours, raise wages, and provide safe working conditions.
11. Two of the greatest advances in technology began chiefly in America: *mass production* and *automatic machines*.
12. With each advance in technology, new problems arise and some small problems become larger. To benefit from our technological society, we must solve each problem as it arises.

Discussion (10)

1. Name some of the kinds of knowledge and skills that men began developing many thousands of years ago. (Hunting, fishing, making pottery, raising plants and animals, weaving, etc.)
2. Where did the first permanent societies evolve? (In Africa, Asia, and the Americas.)
3. Which European people first imported and improved technological skills? (The people of Greece, and later the people of the Roman Empire.)
4. What happened in Europe during the Renaissance? (Many skills were developed and new ones invented. Education, religion, and the fine arts became very important.)
5. What three basic changes started the Industrial Revolution? (Machinery, engines, and the factory system.)
6. How did the Industrial Revolution change people's ways of living? (Open-ended question. Look for mention of job specialization, increased efficiency, more and cheaper products, larger cities, poor working conditions at first, labor unions, etc.)

Laboratory Activity (20)

Briefly demonstrate two ways of shaping clay by hand: coil and slab techniques. See Figs. 1-2 through 1-8 in Laboratory Manual.

1. Divide the class into groups of five.
2. Have the equipment supervisor obtain and distribute the required supplies and equipment.
3. Each student is to work at a specialized task after the group decides what product they will manufacture.
4. Students are to use only the techniques and tools suggested in the Laboratory Manual.
5. Remind students that clay is a messy material with which to work. Care must be taken to protect their clothing, and the laboratory equipment should be left neat and clean.
6. The foreman will assign the work tasks (wedging, forming, separating, combining, or finishing), so that each student specializes in one task.
7. Each group is to manufacture as many units of its product as the laboratory period permits.
8. Explain that the design of each product may vary from those given, but that each unit of a product is to look like all others.
9. Before the end of the period, stop the class and permit each group to display the work of its members.
10. Direct students to return the clay and tools to the proper storage place, and clean their work area thoroughly.

Homework

Reading 3, *Manufacturing and the Economic System*

Note

Prepare for coat hanger production tomorrow.

ASSIGNMENT 6, ACTIVITY 3A
READING 3

Manufacturing and the Economic System

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to manufacturing and the economic system:
   a. State what you could do, as a consumer, if a company's products became poorer in quality than you wanted them to be.
   b. State what a company could do if its natural resources were used up or no longer available.

Discussion

2. Given the text reading on Manufacturing and the Economic System:
   a. Explain the nature of a free enterprise system.
   b. State how the demand for a product affects the supply.
   c. Explain how goods are classed as durable or nondurable.
   d. Give an example of an input-process-output system.
   e. Name several kinds of goods and services that are included in figuring the value of the Gross National Product.

Laboratory Activity

3. Given the necessary equipment and supplies, produce a coat hanger by a *custom* production system.

Time Schedule

5 Overview
5 Discussion
15 Laboratory Activity
20 Demonstration

Equipment and Supplies for Demonstration

Equipment

1 pencil
1 pr. 6″ combination pliers (or side-cutting pliers)
1 36″ bench rule *or* yardstick
1 8″ double-cut metal file
1 pr. 6″ scissors
1 bench knife *or* modeling tool
2 felt markers, red *or* black (Magic Markers)
1 set bending and twisting fixtures Nos. 7-1, 7-2, 7-3, 7-4. See ACTIVITY 3B, Figs. 3B-4, 8, 9, 11
1 paper punch, single hole
1 pc. hanger neck gage, No. 7-57; 5½″ x ½″ I.D. pipe
2 template for hanger No. 7-6. See ACTIVITY 3B, Fig. 3B-15

Supplies

1 pc. ⅛″ dia. 4′ length half-hard aluminum wire (1100 H19)
1 sample coat hanger
1 sht. 22½″ x 34″ chipboard (.030 caliper)

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

2 pr. 6″ combination pliers *or* side cutting pliers
2 36″ bench rules *or* yardsticks
1 sample coat hanger

Supplies (Per student)

1 pc. ⅛″ dia. 4′ length half-hard aluminum wire (1100 H19)

Overview (5)

1. Yesterday you learned that you can produce more and better products when each worker *specializes* in part of the work.
2. Today you read that *manufacturing* is one of two parts of the economic system which produces and services goods to satisfy your wants. The other part of the goods-producing system is *construction.*
3. We will discuss some of the concepts of the American economic system. You will be asked to explain the idea of *free enterprise, supply and demand, and classifying goods as durable or nondurable.*
4. In the laboratory activity each of you will produce a nondurable good: a coat hanger by the custom production process.
5. I will then demonstrate how a coat hanger can be produced more efficiently by use of specialized work and a mass production system. Tomorrow you will manufacture coat hangers by this mass-production system.

Discussion (5)

Today's discussion focuses on the position of manufacturing within the general economic system.

1. What is meant by a *free enterprise* system? (Manufacturers can choose what they will make. Buyers can choose what they will buy.)
2. How does the *demand* for a product affect the *supply* of that product? (Listen for words such as "competition," "quality," "profit," and "selling price.")
3. How would you tell if a product is a durable or nondurable good? (Listen for phrases such as: "length of useful life," "how the product is used or consumed," and "kind of material the product is made of.")
4. Give some examples of an *input-process-output* system. (An educational system, human food consumption, manufacturing, construction, etc.)
5. Name some kinds of goods and some kinds of services that are included when the value of the *Gross National Product* is figured. (Answers will vary. All *goods* and all *services* that have a money value.)

Laboratory Activity (15)

In today's laboratory activity each student will produce a coat hanger by cutting, measuring, and bending 1/8″ aluminum wire.

1. Explain that *each student* will make one complete coat hanger. Show the class the sample coat hanger. Stress that only the tools provided may be used to make the coat hanger. Make note of safety precautions.
2. The class has about 15 minutes to complete work and clean up.
3. Assign groups of five students to their work areas.
4. Members will compare completed hangers within their groups.
5. While the class completes the laboratory activity prepare for your demonstration.

Safety Precautions

1. Wear safety glasses.
2. Keep wire cutters away from your face when cutting wire.
3. Be careful with the ends of the wire; after shearing, the ends are very sharp.
4. When bending wire, don't let it strike you or anyone else.

Demonstration (20)

1. Depending on the number of students in the class, you may wish to set up two identical production lines. Enough fixtures have been supplied for two lines. About 15 students are required to man one production line.
2. Assign workers to all work stations, so each student will concentrate on learning his tasks as you demonstrate. As each student is assigned, he should enter his name on the production flowchart, Laboratory Manual Fig. 3A-3.
3. Following the instructions and figures in Laboratory ACTIVITY 3B, explain and demonstrate the responsibilities for each station.
4. This demonstration need only be performed on one line, even though two lines may be used for actual production.

Homework

None

Note

Set up production lines for mass production of coat hanger. See Assignment 7.

Note

An alternate way to score and fold the chipboard in Assignment 7 is to saw a 3/4″ deep kerf in the edge of a 3/4″ x 2″ x 24″ board. A handsaw blade can be used to depress the chipboard into the groove to make the fold, or the edge of the chipboard can be inserted in the kerf and pressed along the edge to make a fold. See Fig. 3B-18 in the Laboratory Manual.

Manufacturing and the Economic System

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the experience of mass-producing coat hangers by a managed production system, compare this with previous experience in custom production.

Laboratory Activity

2. Given the problem of manufacturing a quantity of coat hangers, perform one specialized task in the production of a coat hanger.

Time Schedule

5 Overview
35 Laboratory Activity
5 Discussion

Equipment and Supplies for Laboratory Activity

Equipment (Per class) (2 production lines)

6 pr. 6″ combination pliers *or* side-cutting pliers
6 36″ bench rules *or* yardsticks
2 8″ double-cut files
4 pr. 6″ scissors
2 bench knives *or* modeling tools
4 No. 7-1 bending fixtures
4 No. 7-2 twisting fixtures
2 ea. No. 7-3 and No. 7-4 bending fixtures
2 pc. No. 7-5 hanger neck gage, 5½″ x ½″ I.D. pipe
2 No. 7-6 template for hanger
2 pencils
2 paper punch, single hole
4 felt markers, red or black

Supplies (Per class) (2 production lines)

120′ ⅛″ dia. half-hard aluminum wire (1100 H19 aluminum)
3 pcs. 22½″ x 34″ chipboard (.030 caliper)

Overview (5)

Today you will continue the study of the development of manufacturing technology.

1. The reading presented the basic structure of the knowledge about manufacturing technology.
2. In the laboratory activity you will put into practice a planned processing system which results in a finished product (coat hanger).
3. You will then compare your experience in custom production with a managed-production system of manufacturing.

Laboratory Activity (35)

In this laboratory activity each student will work as part of a production team to mass-produce coat hangers.

1. To speed up production and involve all students, two production lines can be used. Have the production lines set up before class, with tools and supplies in place and work stations marked.
2. Each student will need to refer to his Laboratory Manual, ACTIVITY 3B, to review his work assignment.
3. Have the students go to their work stations. When all stations are manned, begin the activity by signaling to Stations No. 1 and No. 8 in both production lines.
4. Monitor the stations to assure the smooth operation of the activity and to assure, for example, that Station No. 1 and Station No. 8 do not cut excess stock.
5. Allow approximately 30 minutes for this laboratory activity including cleanup, reorganization of work station, and completion of Laboratory Manual questions.
6. The finished coat hangers may be given to the students, along with their handmade coat hangers, to take home.

Safety Precautions

1. Be careful when cutting wire; short pieces tend to fly and could cause injury.
2. Sharp wire ends must be handled with care.
3. When scoring the chipboard, always keep the knife moving *away from* your fingers that are holding the chipboard.

Discussion (5)

Discuss the events of the laboratory activity and tie in the major elements of the text reading. The following ideas may be used to guide the discussion.

1. Compare the handmade coat hangers with the product of the mass-production line.
2. Have students report on problems of production within their work stations, and recommend corrective action if it is needed.
3. Ask students to review the main steps in mass-producing coat hangers. Develop the basic concepts *planning, organizing,* and *controlling,* which they will study in the next reading.
4. Ask students why it is important for workers to cooperate in the mass production of any product.

Homework

Reading 4, *Manufacturing Technology*

Answers for Laboratory Manual

1. Mass-production process
2. Mass-production process

Note

Look ahead to Assignment 14, 15. Local regulations must be studied before launching a rocket. Some states and cities require permits for handling rocket engines and launching rockets. Make arrangements now for obtaining approval for firing.

ASSIGNMENT 8, 9, ACTIVITY 4A, B
READING 4

Manufacturing Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about manufacturing technology:
   a. Determine who decides what you will have to eat this evening and describe how these decisions are made in your home.
   b. Describe how your father was hired for the job he now has, how he was trained for his work, how his work is being improved.

Discussion

2. Given a presentation on rocket design factors and safety factors,
   a. Name three factors in the design of model rockets.
   b. Name three kinds of materials used in building model rockets.
   c. Name three safety precautions in the construction and use of model rockets.

Laboratory Activity

3. Given the necessary equipment, supplies, and information,
   a. Retrieve the names of parts of a model rocket.
   b. Produce four airframes, using four different fabrication techniques.
   c. Experiment with the airframes.
   d. Describe the qualities of each airframe in relation to weight, strength, shape, and surface smoothness.
   e. Determine the best airframe for use in a model rocket.

Time Schedule

Assignment 8
5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity
Assignment 9
45 Laboratory Activity

Equipment and Supplies for Laboratory Activities

Equipment (Group of 5)

2 pr. scissors
1 12″ rule
1 postal scale 16 oz. by ½ oz.

Supplies (Group of 5)

3 pcs. 4½″ x 5½″ white bond paper, 20#
2 pcs. 5½″ x 8½″ white bond paper, 20#
1 btl. white glue
4 paper towels
1 roll 3″ gummed paper tape
1 roll masking tape, ¾″ width
5 pcs. 1″ dia. x 12″ dowel
1 sponge, small

Overview (5)

The production of coat hangers was preplanned. The purpose of today's discussion and laboratory activity is to introduce you to one of the steps in planning a product: *researching*. By doing research, you will find out which of several rocket airframes would be best for making and flying a model rocket.

1. The text reading explained that manufacturing technology has three main divisions: the technology of management, of production, and of personnel. Planning is one step in management technology. As a part of planning, people do research of several kinds:
   a. They *retrieve* information already known.
   b. They *describe* objects and events.
   c. They *experiment*.
2. I will tell you about materials and safety practices in model rocketry.
3. You will be asked to *name* three factors which influence the design of model rockets, three kinds of materials used in building model rockets, and three safety precautions in building and using model rockets.
4. Problem 1 in the Laboratory Manual asks you to *retrieve* information about the names of parts of model rockets and their functions.
5. In Problem 2 you will produce rocket tubes or airframes.
6. In Problem 3 you will *experiment* with your airframes, *describe* the airframes, and determine which airframe construction would be best for making model rockets.

Presentation (5)

1. The materials used to build model rockets must be *lightweight, strong, smooth,* and *safe to use.*
2. Lightweight materials often used are paper, balsa wood, cardboard, and some plastics.
3. Metallic parts are *not* used in model rockets for two reasons: they are too heavy, and metal could become dangerous shrapnel in the event an engine did not burn properly.
4. Only commercially prepared model rocket engines should be used. Homemade engines are extremely dangerous. Their use has resulted in numerous injuries and deaths. Commercially produced engines are safe and dependable.
5. A remote electrical ignition system is the only safe way to launch a rocket.
6. Local regulations and laws should always be studied and any necessary permits obtained before launching a rocket.
7. Before launching rockets you should become familiar with the *Model Rocketry's Safety Code.*

Discussion (5)

1. What three factors must be considered in selecting materials for building model rockets? (Weight, strength, safety.)
2. Name three materials frequently used in building model rockets. (Paper, balsa wood, plastics.)
3. Name three safety precautions for building and using model rockets. (Use only commercial engines. Do not use metallic parts. Use a remote electrical ignition system. Obey local regulations and laws. Know the Model Rocketry's Safety Code.)

Laboratory Activities (30) and (45)

For the next two days, students will *retrieve* information about model rocket parts, produce airframes, and determine the best means of constructing an airframe.

1. Students will work in regular groups of five. Have the foreman assign numbers to group members for the jobs in Problem 2.
2. All students will complete Problems 1, 2, and 3.
3. Have students clean up and return materials and equipment according to your directions. Tubes can be discarded after the activities are completed.

Homework

None

Note

If time permits, students may sketch rocket designs and the teacher may demon-

strate the engineering concepts of determining the center of gravity and the center of pressure for model rockets. (See Estes or Centuri Educational Package.)

Note
Because time is limited for all of the activities scheduled for ACTIVITY 4C, D, it is suggested that the dowel discs be precut by the teacher on the bandsaw.

Caution
The stability (the ability of the rocket to correct deviations from its intended trajectory) of each rocket produced in class should be tested before the rockets are fired.

Note
Look ahead to Assignment 14, 15 for rocket firing instructions.

For information on determining rocket stability, refer to the following source(s):

1. Stine, Harry G., *Handbook of Model Rocketry,* second edition. Chicago: Follett Publishing Company, 1967.
2. Estes Industries Catalog, center section entitled "Stability."
3. Estes Industries Technical Report TR-1, "Rocket Stability."
4. Estes Industries Technical Report TR-9, "Designing Stable Rockets."
5. Centuri Engineering Co., *A Student's Guide to Model Rocketry.*
6. Centuri Engineering Co., Technical Report TIR-30, *Stability of a Model Rocket in Flight.*

Answers for Laboratory Manual

Problem 1

a. Nose Cone
b. Airframe (body tube)
c. Launch Lug
d. Fin
e. Engine
f. Recovery Device (parachute)
g. Engine Mount
h. Ignition Wire
i. Flameproof Wadding

Problem 3 (Fig. 4A-22)

Weight: heavy, lightest, light, heaviest, 2, 3.
Strength: weakest, weak, strong, strongest, 4, 3.
Shape: least round, not round, round, most round, 4, 3.
Smoothness: smoothest, smooth, rough, roughest 1, 2.
Airframe 3 (probably best selection).

ASSIGNMENT 10, 11 ACTIVITY C, D

Manufacturing Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

Given the necessary equipment and supplies, manufacture model rocket airframes, nose cones, launch lugs, and fins for each member of the group.

Time Schedule

Assignment 10
5 Overview
15 Demonstration
25 Laboratory Activity

Assignment 11
45 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

2 pcs. 1″ x 12″ lacquered dowel
2 pr. scissors
1 sponge
1 coping saw
2 X-acto® knives
1 12″ rule
2 straightedges
1 fin assembly fixtures No. 10
1 hand drill
1 1/16″ twist drill

Supplies (Group of 5)

4 pcs. 8½″ x 11″ white bond paper, 20#
1 roll 3″ gummed paper tape
1 btl. white glue
1 tube household cement (butyl acetate)
5 paper towels
5 No. 12 corks
5 1″ dia. x ½″ dowel (teacher cut or have students cut)
5 No. 8 corks
2 paper soda straws
6 pcs. 1½″ x 14″ binder's board, 3/32″ thick
1 sht. abrasive paper, 100 grit

3 2H pencils
2 newspapers or cardboard (for backup of materials being cut with utility knives)

Overview (5)

1. Yesterday you learned about airframe parts and what kinds of materials are used. You explored the qualities needed for an airframe by doing three kinds of research: retrieving, describing, and experimenting.
2. Today I will demonstrate how to produce and assemble airframes, nose cones, fins, and launch lugs.
3. During the laboratory activity you will work in your regular group. Each person in your group will perform a specialized task. The foreman of each group will assign work tasks to himself and to other group members.

Demonstration (15)

Use the figures in the Laboratory Manual to guide your demonstrations as follows:

1. Fabrication of an airframe (Figs. 4C-1 through 11).
2. Fabrication of a launch lug and its assembly with an airframe (Figs. 4C-12 through 16).
3. Making a fin template, and the layout and cutting of fins (Figs. 4C-17 and 18).
4. Fabrication of a nose cone (Figs. 4C-19 through 23).
5. Assembly of fins and an airframe (Figs. 4C-24 through 26).

Laboratory Activities (25) and (45)

1. Have equipment and supplies ready at each group's work area before class. At the end of each period, the group equipment supervisor can be instructed to replenish supplies.
2. It may be necessary to demonstrate how to drill the screw-eye anchor hole in the disc.
3. Provide temporary storage for completed subassemblies and components.
4. At the end of each activity, instruct students on cleanup procedures.

Safety Precautions

1. Caution students against the careless use of scissors and X-acto® knives.
2. Caution students about the possibility of being cut by the sharp edges of paper and tape.

Homework

Reading 5, *Manufacturing Management Technology*

Note

Prepare facilities for spray painting the completed rockets in Assignment 12. Decide which activities will be done if the rocket unit is carried over into optional Assignment 15. Survey student interests and procure necessary materials and equipment.

ASSIGNMENT 12, 13
ACTIVITY 4E, F, READING 5

Manufacturing Management Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to manufacturing management technology:
   a. Give examples of long-range and short-range planning that your family does.
   b. Describe how a homework assignment is *controlled* by a teacher and by a student.

Laboratory Activity

2. Given the necessary equipment and supplies:
   a. Cut parts for and assemble a parachute for each member of the group.
   b. Attach a shock cord on each airframe-fin subassembly.
   c. Shape, assemble, and apply finish to a nose cone subassembly for each member of the group.
   d. Reinforce fins and apply a finish coat to the airframe–fin–shock-cord subassembly.

Time Schedule

Assignment 12
5 Overview
10 Demonstration
30 Laboratory Activity

Assignment 13
45 Laboratory Activity

Equipment and Supplies for Demonstration

Note

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow. The teacher should have prepared the following before class:

1 3-section parachute pattern, glued to heavy binder's board but not cut out
1 completed parachute pattern
1 completed anchor pattern
1 1″ dia. airframe
1 wire hook for dipping nose cones
mixed enamel and thinner for dipping nose cones (½ and ½)
dipping and spray booths, dipping tanks from milk cartons
storage for parachutes, painted nose cones, painted airframe–fin–shock-cord subassemblies

Equipment and Supplies for Laboratory Activities

Equipment (Group of 5)

3 pr. scissors
1 utility knife (X-acto® knives)
1 straightedge
1 felt tip marker
1 18″ rule *or* yardstick
1 awl
1 pr. pliers (combination side cutters)
1 medium file or power sander
1 pedestal sander

Supplies (Group of 5)

1 btl. white glue
1 roll ¾″ masking tape
1 pc. 12″ x 14″ binder's board *or* heavy cardboard
5 pcs. .001″ x 12″ x 14″ polyethylene fiber (dry cleaning bag)
1 roll shroud cord (kite string)
5 airframe-fin subassemblies
1 tube household cement (butyl acetate)
1 sht. 20# bond paper
5 ⅛″ x 18″ airplane contest rubber shock cords, see Fig. 12-1
1 pc. ¼″ x 6″ dowel
5 cork nose cone subassemblies
5 screw eyes, ¾″ long, *or* staples
1 sht. abrasive paper, 100 grit
½ pt. enamel
½ pt. enamel thinner
½ empty ½ gal. milk carton, cut lengthwise
30″ #18 soft iron wire *or* coat hanger
1 can spray enamel (any color)
2 cardboard boxes, 10″ x 12″ x 14″ minimum, for spray and dip booths
1 thick newspaper or heavy cardboard to back up material during cutting operation

Overview (5)

1. The last two text readings described three technologies involved in manufacturing: (1) management technology which involves planning, organizing, and controlling; (2) production technology which involves preprocessing, processing, and postprocessing; and (3) personnel technology which involves hiring, training, working, advancing, and retiring.
2. Your laboratory activities have concerned planning (doing research needed to build a model rocket) and production (processing materials into completed rockets).
3. Today I will demonstrate the processes necessary to complete the production of a model rocket.
4. During the laboratory activity you will cut and assemble materials for parachutes; attach a shock cord to the airframe–fin subassemblies; shape, assemble, and apply a finish to nose cone subassemblies; reinforce fins; and apply a finish coat of enamel to the airframe–fin–shock-cord subassemblies.
5. You will work in your regular groups. Each student in a group will perform a specialized set of work tasks.

Demonstration (10)

One purpose of this demonstration is to show you how to avoid some problems you might encounter as you do the laboratory activity. You will need to follow the Laboratory Manual carefully to avoid making mistakes.

1. Demonstrate cutting one side of the parachute pattern with a utility knife and straightedge. Point out how the pattern is taped together, how to hold the knife, and how to use newspapers to back up the cutting.
2. Demonstrate the parachute layout on polyethylene film with a completed pattern and felt tip marker. Cut two sides off the plastic with scissors.
3. Demonstrate measuring, cutting, looping, and taping a shroud line to one corner of the cut plastic.
4. Designate where supplies are kept for all students. Point out that each student is responsible for putting away equipment and materials assigned to him. Explain that some supplies and equipment must be shared. Send Students 1 and 2 of each group to work.
5. Demonstrate laying out, cutting, and assembling shock cords to air frame–fin subassemblies. See Fig. 12-1. Send Student 3 of each group to work.
6. Demonstrate rounding the nose cone, attaching screw eyes, and dip painting. Send Student 4 of each group to work.
7. Demonstrate applying cement to reinforce fins and spray-painting the airframe–fin subassembly. Send Student 5 of each group to work.

Laboratory Activities (30) and (45)

1. Students will work in their regular groups for the next two days.
2. Each student within a group will do some specialized part of the production work.
3. Students should begin work as soon as their respective tasks are demonstrated.

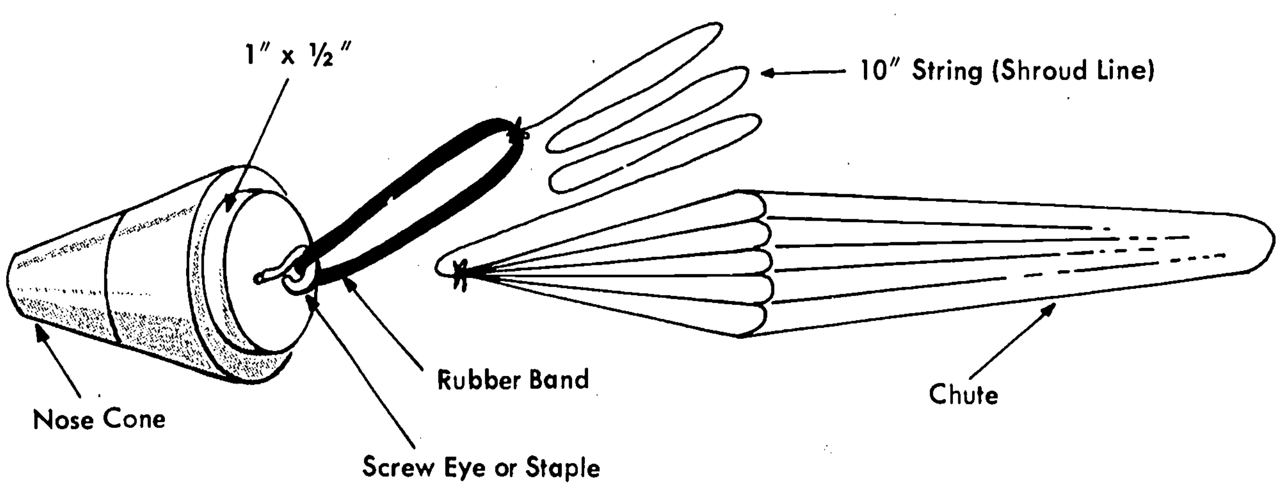


Fig. 12-1. Alternate Rocket–Shock-Cord Assembly

The rubber band and string can be used in place of airplane contest rubber shock cords.

4. Students should put away the supplies and equipment they used as soon as they have completed their assigned tasks. The teacher will designate where rocket parts are to be stored.

Safety Precautions

1. Use care with utility knives, scissors, awls, and finishing materials.
2. Students 4 and 5 of each group should wear shop aprons.
3. Finish materials should be applied in a well ventilated area, away from any flame.
4. Finish materials should be stored in safety containers.

Homework

None, if optional Activity 4H is used. If ACTIVITY 4H is not used, assign Reading 9, *Researching and Developing.*

Note

If optional Assignment 15, ACTIVITY 4H is used, the teacher must decide which activities will be done and how many of each item will be produced. Supplies and equipment must be made available for each group. Look ahead to Assignment 14, 15.

Note

Look ahead to Assignment 17 for the construction of test vehicles for use in Assignment 17. Also, see Assignment 35, 36 for construction of start/finish gates for use in Assignment 18. See Figs. 35-1 to 35-9.

ASSIGNMENT 14, 15
ACTIVITY 4G, H (4H OPTIONAL)

Manufacturing Management Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

Given the necessary equipment and supplies:

a. Apply a second finish coat to IACP rockets.
b. Manufacture engine mounts and assemble with IACP rockets.
c. Manufacture altitude scopes for IACP rockets.
d. Manufacture launch platforms for IACP rockets.
e. Test-fire an IACP rocket.

Time Schedule

Assignment 14

45 Demonstration or Laboratory Activity

Assignment 15 (Optional)

45 Laboratory Activity

Equipment and Supplies for Demonstration

Rocket Firing

Equipment

1 IACP launch platform
1 launch control system (Estes 651-FS-5 or equiv.)
1 6 volt battery (Eveready No. 731 or equiv. 12 volt car battery is good.)
1 IACP altitude scope
1 Estes Educational Packet with No. 691 Catalog
1 IACP rocket

Supplies

2 A5-2 model rocket engines
2 rocket engine igniters
1 roll 3/4" masking tape
1 pkg. recovery wadding
1 1/8" x 36" copper coated mild steel welding rod.

Equipment and Supplies for Laboratory Activities

Finishing, Coating, and Assembly

Supplies (Group of 5)

5 nose cone subassemblies
5 airframe–fin–shock-cord subassemblies
5 parachute subassemblies
1 pt. 50-50 enamel and thinner
1 can spray paint
5 wire paint hooks
2 boxes for dipping and spraying
1 ½ gal. milk carton

Engine Mounts

Equipment (Group of 5)

2 X-acto® knives
2 12″ rules
1 C-clamp
1 pr. pliers

Supplies (Group of 5)

1 0.710″ inside dia. x 18″ paper tube*
1 pencil
1 pc. 1″ x 6″ heavy paper
1 ⅝″ dia. x 3″ dowel
1 btl. white glue
50″ ⅛″ x ⅛″ lightweight softwood

Equipment (Per class)

1 miter box
1 drill press
1 ⅜″ drill *or* ¼″ hand drill

Supplies (Per class)

1 pc. 1″ dia. x 7½″ dowel (¼″/student)

*Note
Shorter pieces may be utilized.

Altitude Scopes

Equipment (Group of 5)

4 pr. scissors
1 3/16″ drill bit
1 hand drill
2 ½″ x 8″ dowel mandrils
1 12″ rule
1 ⅛″ drill bit
1 center punch
1 ball peen hammer
1 pr. tin snips
1 scriber
1 mill file

Supplies (Group of 5)

1 roll gummed paper tape
1 btl. white glue
5 shts. 4¼″ x 7″ white paper
5 shts. 7″ x 7″ cardboard
5 pcs. ½″ x 1″ x 6½″ softwood
5 pcs. 28 ga. 2½″ x 6″ galvanized iron *or* tinplate
5 6-32 x 1″ RH machine screws
5 6-32 hex nuts
5 6-32 wing nuts

Launch Platforms

Equipment (Group of 5)

2 pr. tin snips
2 mill files
1 ball peen hammer
1 center punch
2 pr. pliers
2 4″ screwdrivers

Supplies (Group of 5)

5 pcs. 28 ga. 6″ x 6″ galvanized iron *or* tinplate
15 ⅛″ x 1″ FH machine screws with nuts
5 pcs. ⅛″ x 24″ welding rod
10 6-32 hex nuts
5 ¾″ wood cubes with ⅛″ hole drilled halfway through
1 pc. 6″ x 6″ heavy cardboard

Equipment (Per class)

3 6-32 threading dies
3 die stocks
1 drill press
1 ⅛″ twist drill

Demonstration or Laboratory Activities (45) and (45)

More activity has been planned for this optional day than can be accomplished by all students in one class period. Each teacher must decide how many activities will be done, how many items of each type are to be produced by a given class, and what time allowance needs to be made. Suggested alternatives are:

1. **Rocket Firing Demonstration**
   Rocket launching may be demonstrated during the class period *or* after school. The latter plan leaves more time for laboratory activities. See DEMONSTRATION.

2. **Finishing Coat and Assembly,** Problem 1

   Applying a second coat of finish to the rockets provides an opportunity for some or all students to improve the appearance of their rockets and possibly to personalize the rocket by adding decals, stripes, their own color scheme, etc.

3. **Engine Mounts,** Problem 2

   If all students are interested in launching their rockets, the entire class may manufacture engine mounts *or* part of the class may work on this activity while other groups produce altitude scopes and/or launch platforms. Alternate methods of constructing engine mounts can be located in Estes Model Rocketry Catalog. If an alternate is used, make the necessary changes in Problem 2.

Note

If engines other than those specified are used for launching, it is suggested that the diameter of the hole in the rocket engine mount be increased from 1/4″ to 3/8″ to assure parachute ejection. The restrictive 1/4″ passage may cause the engine to be ejected rather than the nose cone and parachute.

4. **Altitude Scopes,** Problem 3

   All students may manufacture altitude scopes *or* part of the class may work on this activity while other groups produce engine mounts and/or launch platforms.

5. **Launch Platforms,** Problem 4

   All students may manufacture launch platforms *or* part of the class may work on this activity while others produce engine mounts and altitude scopes.

6. **Class Coordination**

   The activities provide specialized jobs for each member of the regular group. Coordination of specialized effort should permit producing several units of each item and possibly three or four different items during a class period.

Demonstration

1. If rocket firing is selected for demonstration and activity, the teacher is referred to pp. 64-65 (launching) and pp. 70-71 (tracking) of Estes Catalog No. 691 for information needed to launch and track an IACP rocket. The safety code, p. 3 of the same catalog, should also be studied carefully before the demonstration.
2. Local regulations must be studied before launching a rocket. Some states and cities require permits for handling rocket engines and launching rockets.
3. The IACP rocket with an A5-2 engine should reach an altitude of about 400′. The minimum size of the launch and recovery area should therefore be 400′ x 400′.

Safety Precautions

1. Exercise care in the application and storage of flammable finish materials.
2. Newspapers or cardboard will be needed to back up construction materials when cutting parts for engine mounts.
3. Wear goggles and use pliers for holding when drilling holes in sheet metal. Be careful of sharp edges on sheet metal.
4. Be especially careful when handling the small-diameter rods for the launch pad. A cube should be installed over the top end of the rocket launch platform rod, to prevent the possibility of eye injury.
5. Follow *carefully* all *safety procedures* listed in the Estes Education Packet when handling materials and launching rockets.

Homework

Reading 9, *Researching and Developing*

Note

Look ahead to Assignments 61 to 81 concerning Product and Process R & D. Start gathering ideas for possible simple products that can be designed, engineered, and mass-produced within about 18 periods. Thought should be given to utilizing some of the specialized equipment you have in your laboratory. Thought should also be given to student interest in selecting possible products. You should also consider the availability of materials. *The teacher will need to limit the constraints for the product so that students do not get embroiled with too complex and difficult a product* for the time available. See Fig. 61-1.

ASSIGNMENT 16, ACTIVITY 5A
READING 9

Researching and Developing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to researching and developing:
   a. List the kinds of research and development which would go on in a major automobile manufacturing company.
   b. Discuss ways in which the *results* of research have more than paid for its *cost*.

Discussion

2. Given a presentation on researching and developing:
   a. State the main goals of research and development.
   b. Explain the three main ways of doing research: *retrieving, describing,* and *experimenting*.

Laboratory Activity

3. Given land speed record data, *retrieve* and record information.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Overview (5)

1. Yesterday you learned about manufacturing *management* technology and its three subelements: *planning, organizing, and controlling.*
2. Today's reading assignment concerned *researching* and *developing.* I will explain these activities further.
3. You will be asked to state the goals of *research and development,* and explain three main ways of carrying on research.
4. In the laboratory activity you will *retrieve* information about land speed record assault vehicles, land speed records, and land speed testing areas.

Presentation (10)

Researching and *developing* are among the most important and necessary activities for technical progress in manufacturing industries.

1. *Research has two main goals:*
   a. To satisfy man's desire to understand some part of the physical universe.
   b. To provide knowledge needed to solve problems important to man's welfare.
2. *Development has one main goal:*
   To provide processes or products to satisfy human wants and needs.
3. Research is carried on in three main ways: by *retrieving, describing,* or *experimenting.*
   a. *Retrieving* means "finding again" — locating and collecting information already known. This information may exist in books, research reports, and other written records. It may be found in libraries or research laboratories. Retrieving answers the question, "What was?".
   b. *Describing* means using words, numbers, diagrams, or other devices to tell about something. It answers the question, "What is?" A researcher describes some special qualities of an object or material. These qualities that set something apart are called its *characteristics.*

      An item may share some of its characteristics with other items. If we are describing a group of similar items, we try to describe characteristics that will explain how they are *alike* as a group, and also how they *differ* from one another.

      Some of the qualities often described relate to our sense organs and the information they receive. Color, shape, texture, smell, sound, taste, weight, and size are qualities of this kind. To describe qualities like weight and size, we also use measuring devices and units of measure. For example: you might describe a boy by saying that he is 5′ 6″ tall and weighs 120 pounds. The *quality* then becomes a *quantity.*

      As another example: in describing automobiles, we would select certain qualities on which to collect data. These might have to do with size, body style, engine displacement, or horsepower.

c. *Experimenting* means testing or trying something in a planned way. It attempts to answer the question, "What will be?" An experimenter tries to keep everything constant, or unchanging, except one factor. He varies that factor and looks for differences in results.
4. *Basic research* is a search for knowledge that is valued for its own sake. Often this knowledge leads to other research that has a practical application. Learning about the sun's radiation is basic research.
5. *Applied research* is a search for knowledge that can solve a practical problem. Finding a way to protect astronauts from the sun's radiation is applied research.
6. *Development* involves designing and engineering new or improved processes or products, using research findings and other knowledge.
7. *Research and development* (called "R & D") keep industry going, growing, and progressing.

Discussion (5)

To review today's presentation, pose the following questions:

1. What are the goals of research? (To satisfy man's desire to understand his physical universe. To provide knowledge needed to solve problems important to man's welfare.)
2. What is the goal of development? (To provide processes or products to satisfy human wants and needs.)
3. What are the three main ways of doing research? (Retrieving, describing, and experimenting.)
4. Explain *retrieving*. (Collecting information already known, that relates to the knowledge being sought.)
5. How do you go about *describing* something? (Give information about some of its special qualities or characteristics.)
6. What is *experimenting*? (Testing in a planned way. Changing just one factor and looking for the effects of the change.)

Laboratory Activity (25)

This laboratory activity deals with retrieving information.

1. Students will work individually.
2. Check to see that students understand what they are to do.

Homework

None

Note

The teacher will need to construct a set of test vehicles for use in Laboratory ACTIVITY 5B. A list of required materials and procedures for making the vehicles appear at the end of Assignment 17.

Also see Assignment 35 for construction of *Start-Finish Gates* for use in Assignment 18. See Figs. 35-1 to 35-9.

Answers for Laboratory Manual

	GREEN MONSTER	SPIRIT OF AMERICA (Sonic 1)	BLUE BIRD (C. N. 7)	BLUE FLAME
Vehicle Speed	576 +	600 +	403 +	622.40 one-way
Year Achieved	1965	1965	1964	1970
Test Location	Salt Flats Bonneville, Utah	Salt Flats Bonneville, Utah	Lake Eyre, Australia	Salt Flats Bonneville, Utah
Type of Power	Turbojet	Turbojet	Gas Turbine	Liquid Fuel Rocket
Number of Wheels	4	4	4	4
Driver's Name	Arfons	Breedlove	Campbell	Gabelich

Researching and Developing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a problem situation:
   a. Name the limitations, constants, and variables involved.
   b. Propose one way of performing an experiment to solve the problem.

Laboratory Activity

2. Given the necessary equipment and supplies, conduct an experiment to determine which of three test vehicles exhibits the least friction on bearing surfaces.

Time Schedule

5 Overview
5 Presentation
10 Discussion
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1 pc. 4′ x 8′ hardboard, 1/8″ *or* 1/4″ thick, for test track
1 set of 3 test vehicles, as follows:
Vehicle A, wood serves as bearings
Vehicle B, soda straw bearings (plastic *or* waxed paper)
Vehicle C, nylon bearings
1 6′ steel tape
1 pc. 2″ x 6″ x 48″ (approx.) pine *or* fir

Overview (5)

1. Yesterday you learned that *research* is done by *retrieving, describing,* and *experimenting.*
2. Yesterday you performed *research* activities by retrieving.
3. I will explain the meaning of *limitations, variables,* and *constants* as they relate to *experimenting.*
4. I will give the class a problem situation. You will be asked to name some limitations, constants, and variables, and to propose an experimental design for the problem.
5. In the laboratory you will run an experiment to determine the best axle bearing for a model Land Speed Record Assault Vehicle and determine the limitations, constants, and variables.

Presentation (5)

1. Experiments are conducted by the *research and development* personnel of most large manufacturing companies, and by many other organizations engaged in research and development.
2. An experiment is an attempt to answer a question or solve a problem. Can you think of problems in which you might have to experiment to get an answer? Here are some examples. "Which is the best toothpaste: Brand X or Brand Y?" "Which kind of spot remover will take grease spots off clothing most quickly and safely?" "Which style and composition of shoe heel wears best for construction workers who work in mud all the time?" "Which of six samples of wood is the lightest?" The number of problems is endless.
3. *A problem must first be identified.* Then it must be defined in more detail. Certain limits or *limitations* must be stated. Let us look at the problem of the six wood samples. The problem rewritten with its limitations might be stated like this: "Which of six pieces of 3/4″ x 2″ x 12″ kiln-dried wood is the lightest in weight, when weighed on a scale which is accurate to 1/2 an ounce?"
4. In a planned experiment, there are always some things that change while others remain the same. The factors that change are called *variables.* Those that remain the same are called *constants.* What are the variables and constants in the wood problem? The variables are the different types of wood and their weights. The constants are the size of each piece, the scale for weighing, and the fact that all samples were kiln-dried.

Discussion (10)

Pose this problem to the class:

Everything has progressed smoothly in the manufacture of your model rocket. You are now ready to fire the rocket in order to

test out its design and operation. After setting up the rocket on the launch pad, you fire it off to a height of 400′. The ejection charge blows out the nose cone and parachute, but the chute *fails to open*. The rocket falls rapidly to the ground causing damage to the fins and body tube.

1. Who can make a problem statement for this problem?
   Problem Statement: To make the parachute open immediately after ejection and thus allow the safe return of the rocket.
2. What are the limitations of the problem?
   Limitations
   a. It is necessary that the chute be made of a material which can be folded.
   b. The chute material must be very light and strong.
   c. The chute material must be pliable.
   d. It must be easy for string to be attached to the chute material.
3. What are the constants in the experiment?
   Constants
   a. The space in which the parachute is stored.
   b. The ejection charge.
4. What are the variables?
   Variables
   a. Thickness of plastic used for chute.
   b. Method of folding the chute.
   c. Shape of the chute, i.e., six or eight sides.
5. How could this experiment be conducted?
   Experimental Design
   You could make the chute using a thinner type of plastic and then test it for operation. You could try different ways of folding the chute and test each method. You could make the chute completely round or with any number of sides to determine if the shape of the chute helps it to open quickly after ejection.
6. What procedure did we use in this problem?
   a. State the problem.
   b. Identify limitations.
   c. Identify constants.
   d. Identify variables.
   e. Describe the experimental design.

Laboratory Activity (25)

Today the students will conduct *research* by *experimenting*.

1. Using the equipment, demonstrate the procedure they are to follow. See Teacher's Guide Figs. 17-4 through 17-8.
2. Have vehicles ready. Friction test tracks should be prepared and assembled before class and should remain set up for all classes.

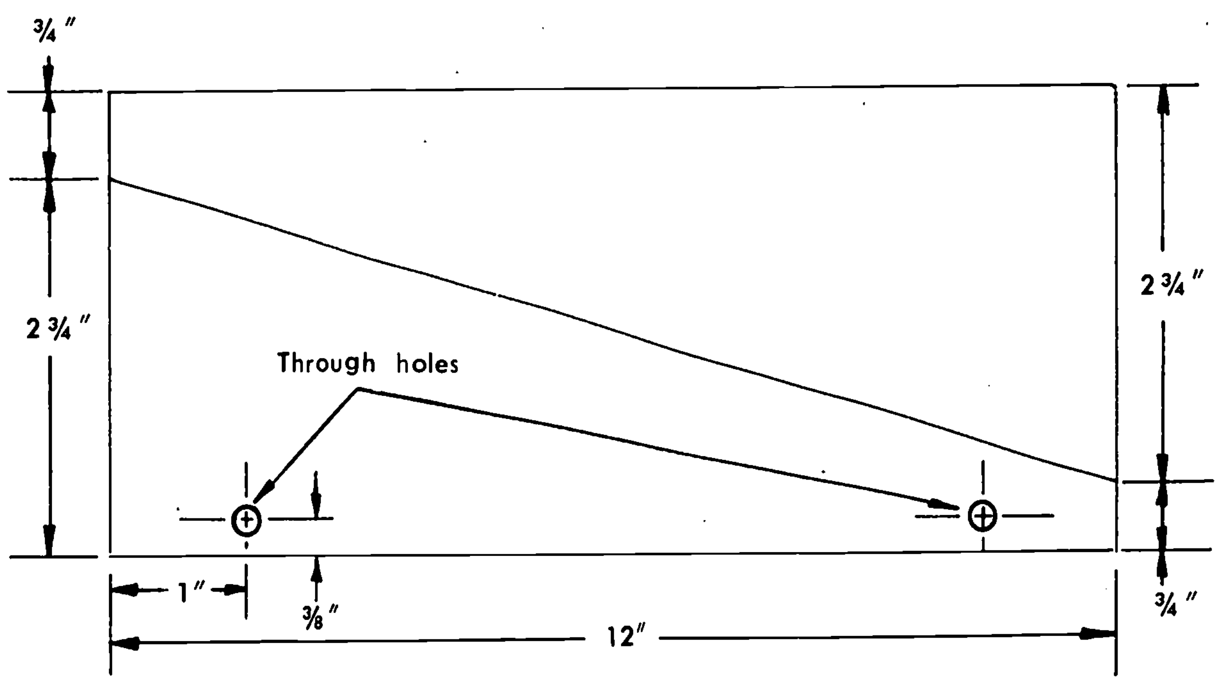


Fig. 17-1. Pattern for Cutting Test Vehicle Bodies
Cut two (2) from a 2″ x 4″ x 12″ piece of lumber.

Notes:

1. For Test Vehicle A with no bearings, drill 9/64″ holes.
2. For Test Vehicle B with soda straw bearings, drill 3/16″ holes or drill to fit.
3. For Test Vehicle C with nylon bearings, drill 3/16″ holes or drill to fit.

3. If necessary, give help with figuring average distances for test runs.
4. Allow time for answering questions in the Laboratory Manual.

Homework

Reading 10, *Designing Manufactured Goods*

Answers for Laboratory Manual

1. B-straw
2. Straw
3. Applied

Instructions for Making One Set of Three Vehicles

Materials

3 pcs. cut from 2″ x 4″ x 12″ pine (knot-free). (See Fig. 17-1. Each block makes two bodies.)

6 pcs. 1/8″ dia. x 2 1/2″ brazing rod *or* welding rod *or* heavy duty coat hanger wire

4 pcs. .130 I.D. x 5/32″ O.D. x 1/2″ long nylon (See Fig. 17-2.)

2 pcs. 1 5/8″ long waxed paper soda straw (See Fig. 17-3.)

12 #6 brass washers

12 1 1/8″ dia. plastic wheels w/1/8″ axle hole

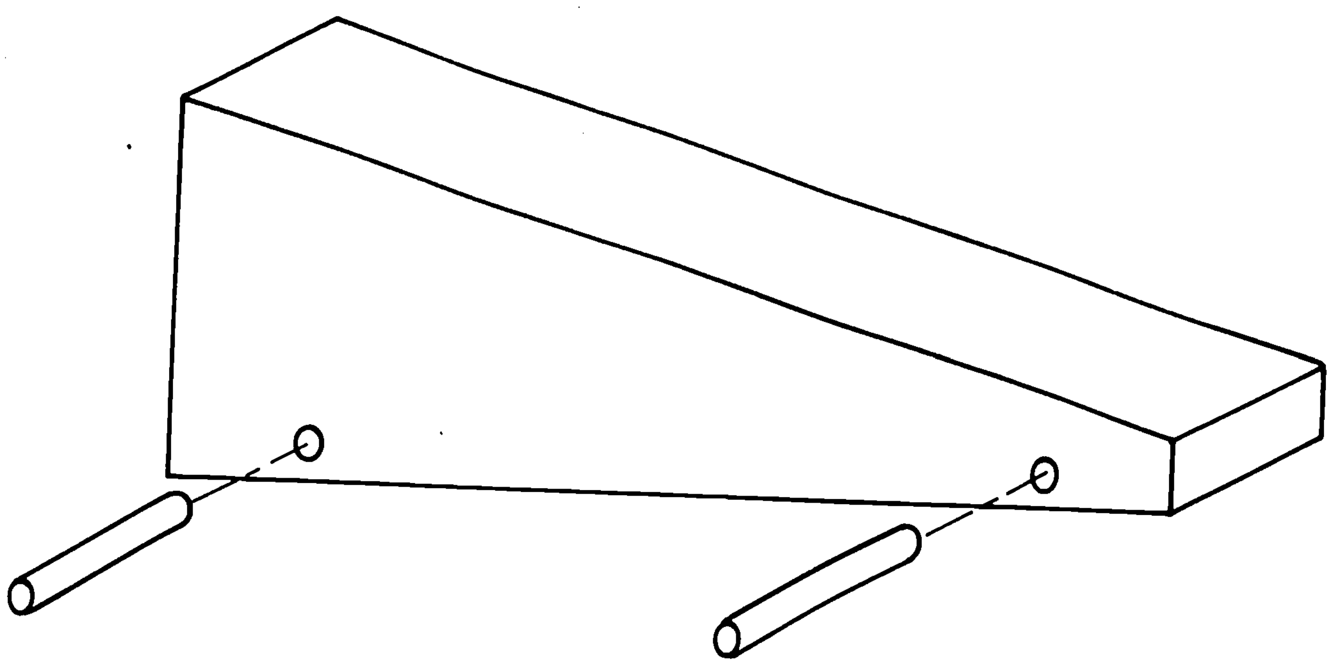


Fig. 17-2. Inserting Soda Straw Bearings
Note: Two (2) soda straw bearings (plastic or waxed paper) 1 5/8″ long are required.

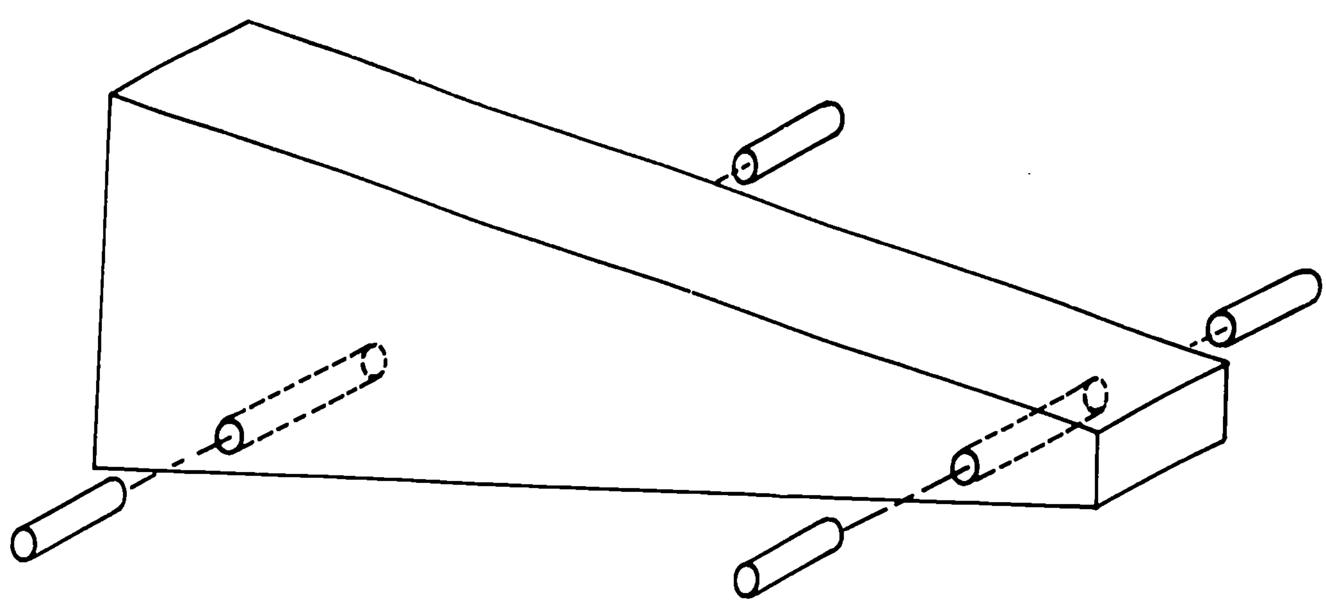


Fig. 17-3. Inserting Nylon Bearings
Note: Four (4) nylon bearings 1/2″ long are required.

Procedure

Figure 17-1 is a pattern for a vehicle body. Holes are drilled for axle assemblies. Vehicle A has no bearings. Vehicle B has soda straw bearings, shown in Fig. 17-2. Vehicle C has nylon bearings, shown in Fig. 17-3.

Note

See Assignment 35-36 for construction of Start-Finish Gates for use in Assignment 18.

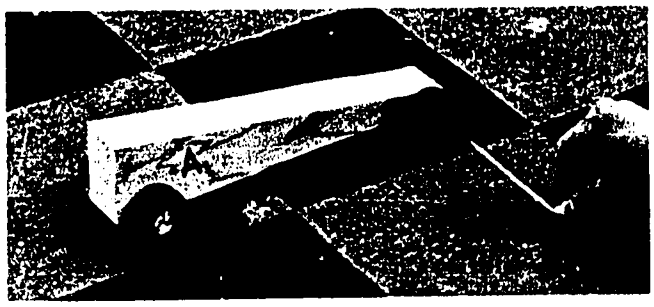


Fig. 17-6. Line Drawn Where Vehicle Stopped

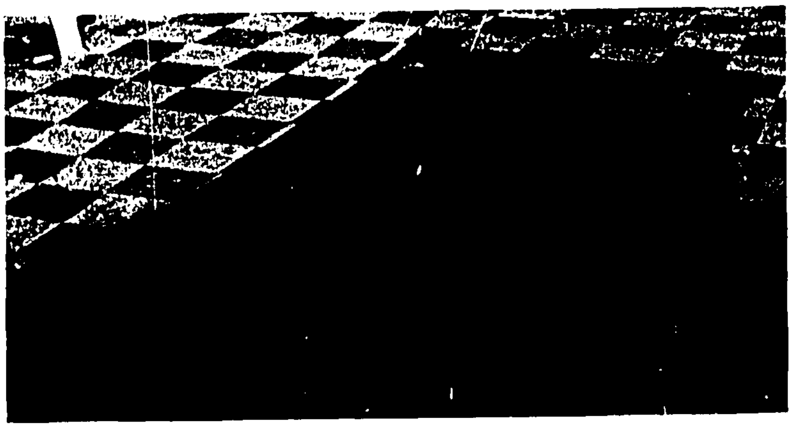


Fig. 17-4. Test Track

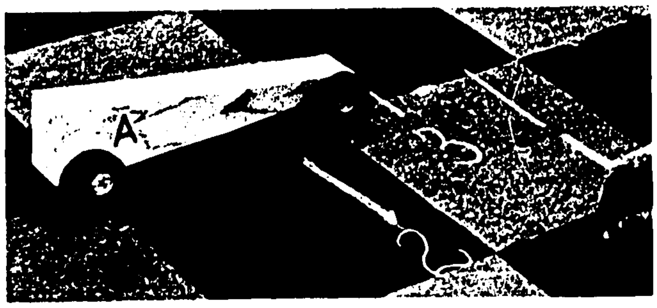


Fig. 17-7. Measuring for Average

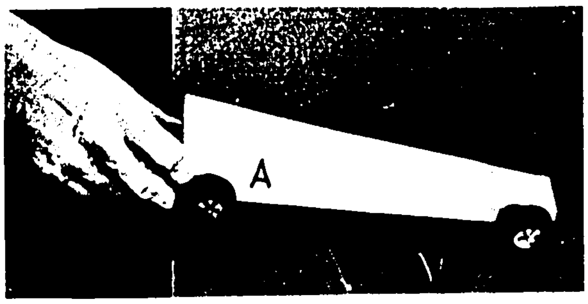


Fig. 17-5. Test Car in Position
Draw chalkline where vehicle starts.

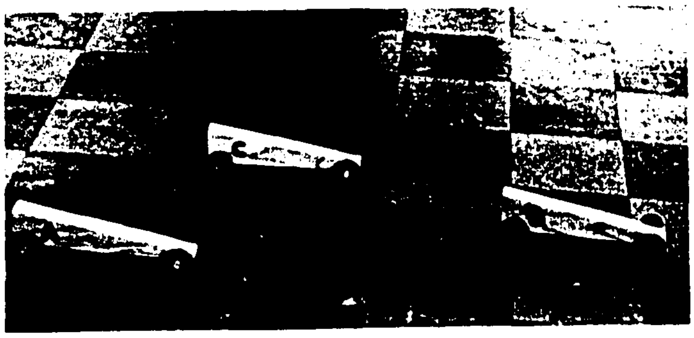


Fig. 17-8. Relative Position of Test Cars

ASSIGNMENT 18, ACTIVITY 6
READING 10

Designing Manufactured Goods

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading about designing manufactured goods:
   a. Discuss whether the *appearance* or the *function* of a new automobile is more important to you.
   b. List products which could be purchased without actually *seeing the product* through the package.

Discussion

2. Given a presentation on product designing, identify the major steps necessary to begin a product design.

Laboratory Activity

3. Given the problem of designing a Land Speed Record Assault Vehicle, select the *limitations*, *constants*, and *variables* which influence the design of the vehicle.

Time Schedule

5 Overview
5 Presentation
5 Discussion
5 Demonstration
25 Laboratory Activity

Equipment and Supplies for Demonstration

Equipment

1 set start/finish gates (See Assign. 35, 36)
1 sample vehicle
1 overhead projector/screen

Supplies

1 CO_2 cartridge
1 Transparency 18, *Design Factors* w/overlays
1 transparency marking pen *or* grease pencil

Overview (5)

1. In the last class period, you learned that research may consist of retrieving, describing, or experimenting.
2. You also experimented to find which of three wheel bearing materials provided the least resistance.
3. Today's reading explained product designing and the product designer.
4. I will show you a sample product and we will begin designing a product.

Presentation (5)

Today's work concerns *product designing* as it is practiced in industry.

1. A product is first identified for possible future production by a *sales forecast.* A sales forecast is based on a *survey* taken to find out if there will be a market for a product: that is, whether people will want or need it enough to buy at a suitable price. A baseball mitt is an example of a product for which you might *survey* the *market*.
2. Some *limitations* of the product design are obtained by analyzing the sales forecast. In our example, limitations would include the age group of people using baseball gloves; the style of glove most popular for catchers, outfielders, first basemen, etc.; left- or right-hand design; season of the year when baseball gloves are used; and the number of gloves purchased in a year.
3. Additional design limits may be set by the product designer. For example, if we are going to produce baseball gloves for males, age 12-16, we will need to know the average hand sizes of boys 12-16.
4. The product design is started by *thumbnail* sketches, showing many ideas.
5. Some thumbnail sketches are developed into *rough* sketches.
6. The best roughs are *refined,* keeping the design limitations in mind.
7. *Mock-ups* of one or two designs are presented to management for approval.

Discussion (5)

The following questions reflect the design process.

1. What kinds of *limits* are placed on the product designer's ideas? (The design must suit the particular customer group that is expected to buy it. It must be right for their ages, their needs, and their ability to pay.)

2. What kinds of *product information* does the *product designer* use to guide his work? (Information about wanted sizes, dimensions, shapes, strength needed, or other physical properties.)
3. *How* or *where* does the *product designer* get *product information*? (Information is obtained by research, done by the designer or by others.)

Demonstration (5)

The teacher will use a sample vehicle to demonstrate how a completed LSRAV will operate.

1. Before class, have a single tether line set up in class.
2. Thread a vehicle onto the tether and insert a cartridge.
3. Make certain the track is clear. Then activate the cartridge.
4. Retrieve the vehicle and begin the activity.

Caution

The sample vehicle should be very simple so as not to influence students' designs.

Laboratory Activity (25)

Today the class will help in setting design limits for a Land Speed Record Assault Vehicle.

1. Review the following information with the students: (List on chalkboard.)

Given: (All students must use these; no substitutes.)

powerplant	bearings
wheels	axles
axles	block for body

Limits on Design

Must be uniform length — 12″
Powerplant must be enclosed
Powerplants must be uniform in location
Axles must be enclosed
Centerline of axles must be uniform in height
Body must be made from single piece

2. Discuss each of the design factors with the students. Decide which factors are limitations, constants, and variables. Have them fill in Figure 6-1 in the Laboratory Manual as a result of the discussion. List factors on Transparency 18, *Design Factors*, as they are developed.
3. A completed copy of the student's chart is included here. See **Fig. 18-1.** It is important that the students develop this information. The completed chart is for comparison only.

Homework

Reading 11, *Creating Alternate Design Solutions*

Note

See Assignment 19 for construction of camera mock-up for use in Assignment 19.

Answers for Laboratory Manual

Fig. 18-1. Design Factors

Factors	Limitations	Constants	Variables
Body Limitations			
Length	12″ minimum and maximum	12″	none*
Width	1⅝″ maximum	1⅝″ minimum width at axles*	width can vary between axles*
Height	2¾″ maximum	must enclose axles and engine*	height can vary between axles*
Shape	⅜″ min. diameter one full piece	one full piece	any number of shapes
Axle housing	axles must be enclosed	1⅝″ minimum width at axles	none*
Color	none*	may be constant	may be variable
Material	softwood	softwood	none
Power Plant Limitations			
Size and material	metal cartridge	¾″ dia. x 2½″	none*
Location	totally enclosed	center line ⅞″ above axle center line at all points	none*
Housing size	⅛″ min. thickness around cartridge	¾″ dia. x 2″	none*
Axle, Bearing, Wheel Limitations			
Axle size and material	⅛″ dia. metal rod	⅛″ dia. x 2½″	none*
Bearing size and material	⅛″ I.D. minimum*	⅛″ I.D. waxed paper tube	none*
Wheel size and material	1⅝″ dia. plastic*	1⅝″ dia. plastic	none*
Axle location	center line ⅜″ from bottom	ground clearance	wheelbase
Steering System Limitations			
Screw eye alignment	on center line*	on center line	none*
Distance between screw eyes	minimum 6″ apart	screw eyes*	none*

***Students will record these answers in their Laboratory Manuals.**

ASSIGNMENT 19, ACTIVITY 7A
READING 11

Creating Alternate Design Solutions

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about creating alternate design solutions:
   a. List reasons why top management might reject a designer's rough sketches.
   b. Discuss what happens to alternate design solutions which are not used.

Discussion

2. Given a demonstration of the process by which alternate design solutions are created:
   a. Name four design steps followed by industrial designers.
   b. Recall the common name for preliminary sketches.
   c. State why crude, free-hand sketches are valuable.
   d. State why it is desirable to keep many "thumbnails" and unfinished rough sketches.
   e. Name a device designers use to get an idea of the general shape and size of a design solution.

Laboratory Activity

3. Given the problem of designing a Land Speed Record Assault Vehicle:
   a. Make several thumbnail sketches.
   b. Make rough sketches based on three of the thumbnails.
   c. Refine one rough sketch.

Time Schedule

5 Overview
10 Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Demonstration

Equipment

1 overhead projector/screen *or* use chalkboard

Supplies

1 grease pencil
1 Transparency 19 (a blank transparency to be used for sketching)
1 ea. mock-up of LSRAV

Equipment and Supplies for Laboratory Activity

Supplies (Group of 5)

20 shts. 8½″ x 11″ sketch paper
5 colored pencils, felt markers *or* crayons in assorted colors
1 file folder
5 shts. carbon paper

Overview (5)

1. Yesterday you learned that limits are set on any product design and that the product designer must stay within these limits.
2. In today's text reading you learned that the product designer develops various kinds of sketches and mock-ups to help him study and evaluate alternate solutions to a problem.
3. Today I will demonstrate the steps designers usually follow to create alternate design solutions: (a) making thumbnail sketches; (b) making roughs based on the thumbnails; (c) selecting alternate roughs and refining them; and (d) making a hard mock-up.
4. You will be asked to name four steps usually followed in creating alternate design solutions and state why sketches and mock-ups are valuable.
5. During the laboratory activity you will have an opportunity to apply the design process to create alternate design solutions for a Land Speed Record Assault Vehicle.

Demonstration (10)

In this demonstration a design will be developed from the thumbnail sketch through the hard mock-up stage.

1. Many simple sketches, called *thumbnails*, start the four-step design process. Show Transparency 19.

Sketch three LSRAV designs. Sketch quickly, using a very simple style. See Fig. 19-1.

2. *Rough sketches* are developed to refine various "thumbnail" ideas. The "roughs" are then refined further. (Show how a very crude "thumbnail" is resketched, keeping its idea but developing it into a recognizable rough. Also show how to "pick up" part or all of a sketch by laying tracing paper over it and tracing whatever is worth copying. See Fig. 19-2.)
3. Of the possible roughs, a single design seems to hold the most promise. (Choose LSRAV C.) The designer then makes a *refined sketch* of this selected design. See Fig. 19-3.
4. Mock-ups of the refined sketch are made, ranging from paste-ups through hard mock-ups, for appearance and for testing. A mock-up helps to visualize actual size and shape. (Show a pre-made mock-up of an LSRAV.)

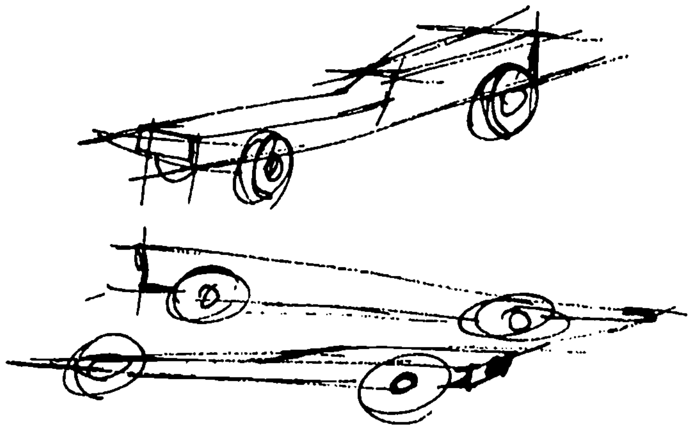


Fig. 19-1. Thumbnail Sketches

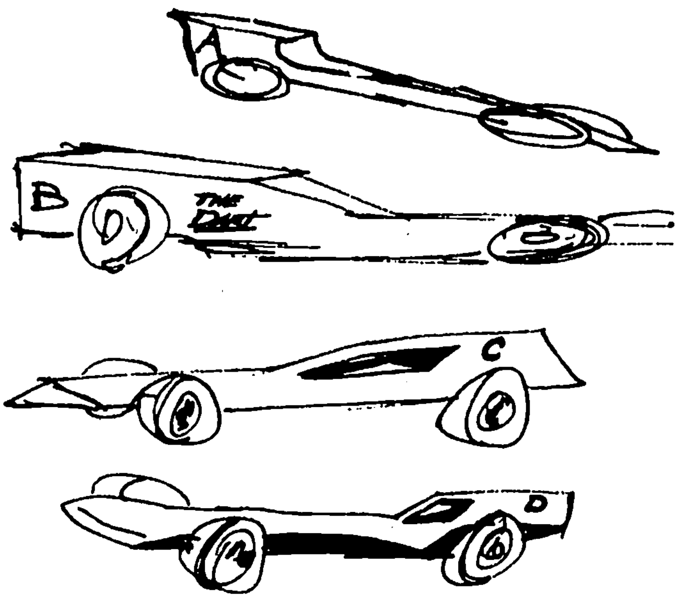


Fig. 19-2. Rough Sketches

Fig. 19-3. Refined Sketch for the Selected Best Design

Discussion (5)

1. What four design steps are usually followed by the industrial designer? (Thumbnail sketches, rough sketches, refined sketches, mock-ups.)
2. What are the preliminary sketches of a product design called? (Thumbnail sketches.)
3. Why are crude, free-hand sketches valuable? (Because they capture ideas.)
4. Why is it desirable to keep many "thumbnails" and unfinished rough sketches? (In industry, the product designers refine many ideas and designs before they reach a final design solution.)
5. How does the designer get an idea of the general shape and size of the design solution? (A mock-up is built.)

Laboratory Activity (25)

Today the students will follow the design process from thumbnail sketch, through rough sketches, to a refined sketch of the design of the Land Speed Record Assault Vehicle.

1. Have students work at tables in groups of five, even though sketches will be made individually.
2. Each student will make rapid, simple thumbnail sketches of design ideas for his Land Speed Record Assault Vehicle. Ask for quick, simple sketches. Let each student sketch in any manner which is comfortable to him.
3. Instruct students to make two or three thumbnail sketches, then select the best design.
4. Each student will make a rough sketch based on his best design.
5. Each student will refine the rough sketch.

Homework

None. Students not completing their sketch can finish it for homework.

Note

Look ahead to Assignment 20. You will need to draw Fig. 20-1 and duplicate at least one copy for each student. See Fig. 20-1, Design Grid for LSRAV.

Answers for Laboratory Manual

1. Thumbnail
2. Rough
3. Refine the rough sketches
4. To explore many possible ideas or solutions to this problem

ASSIGNMENT 20, ACTIVITY 7B

Creating Alternate Design Solutions

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a demonstration of projection drawing, state the names of two views and indicate their relationship.

Laboratory Activity

2. Given a refined sketch produced in ACTIVITY 7A, develop the sketch into a full-scale drawing showing the top view and front view.

Time Schedule

5 Overview
5 Demonstration
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Demonstration

Equipment

1 overhead projector/screen
2 felt tip marking pens, in assorted colors

Supplies

1 Transparency 20, *Grid*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5 pencils
2 erasers
5 12″ rules *or* straightedges
2 French curves *or* coins

Supplies (Group of 5)

1 file folder with sketches from ACTIVITY 7A
5 shts. 8½″ x 14″ preprinted grid paper*

*See Fig. 20-1. Remove both pages from Teacher's Guide, join as shown, and duplicate.

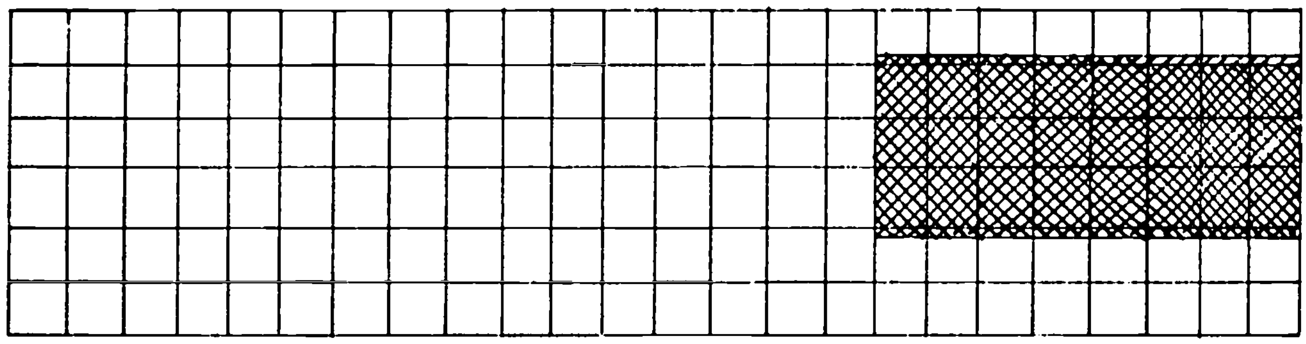
Overview (5)

1. Yesterday you made refined sketches of alternate designs for your Land Speed Record Assault Vehicle.
2. Today you will learn how to draw *front* and *top* views of an object.
3. You will be asked to name two views of a *projection drawing* and state their relationship.
4. In the laboratory activity you will develop a refined sketch into a full-scale drawing. You will draw the top and front views of your vehicle. The drawing will later be used to make a *hard mock-up* of the Land Speed Record Assault Vehicle.

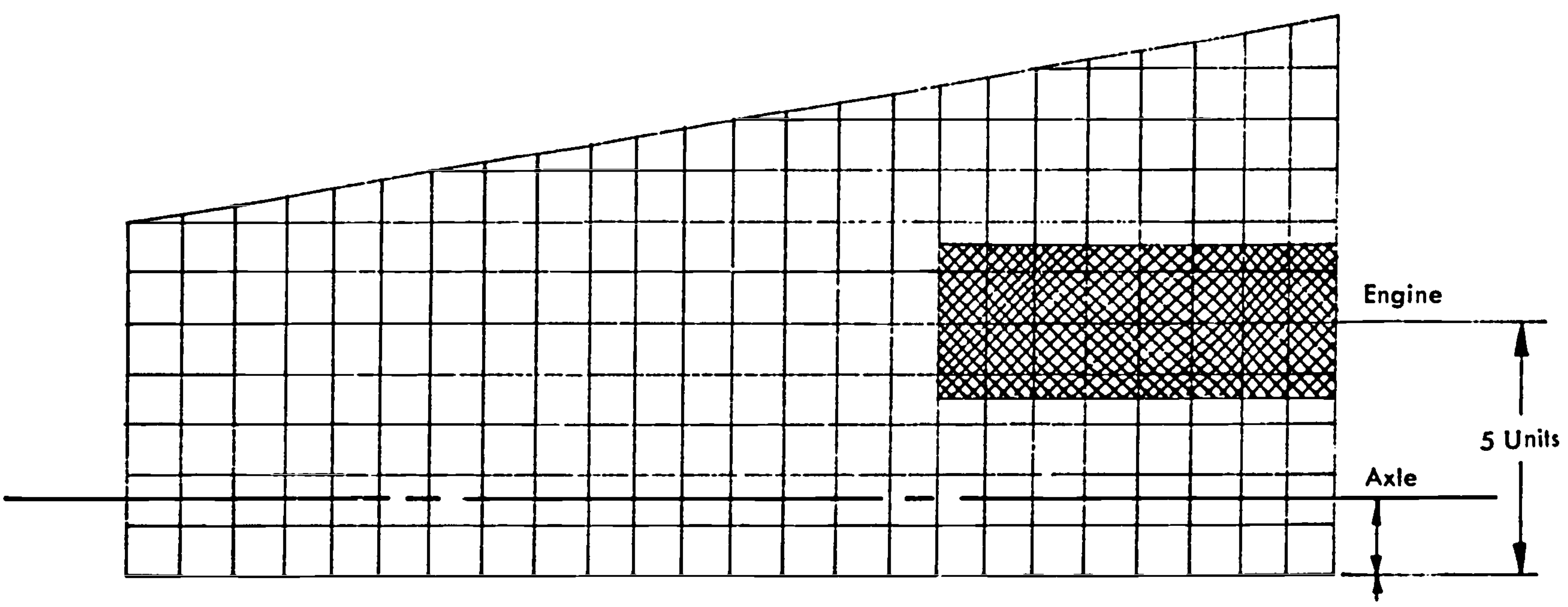
Demonstration (5)

After thumbnails and refined roughs are sketched, the designer begins drawing the product in a very exact way.

1. *Sketching* usually is done freehand. *Drawing* is done with the help of a



Top View



Front View

(Right Half of Grid Sheet)

LSRAV Body

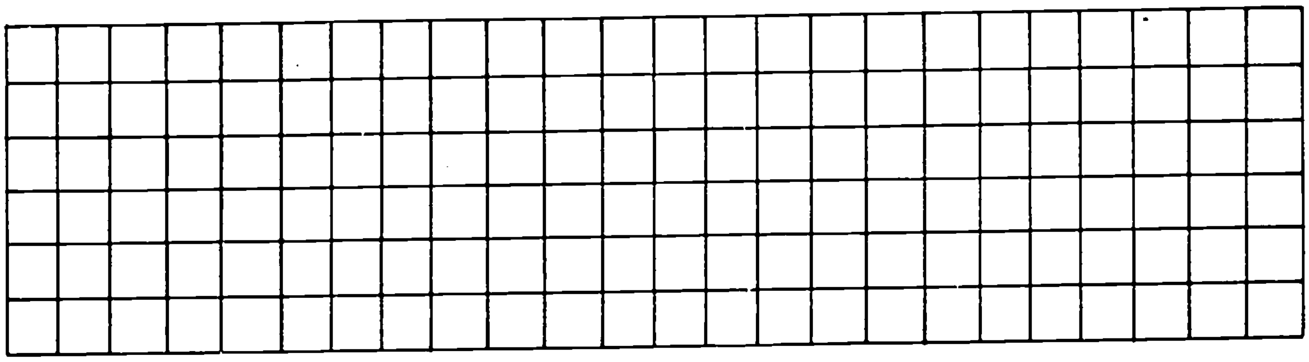
Name ______

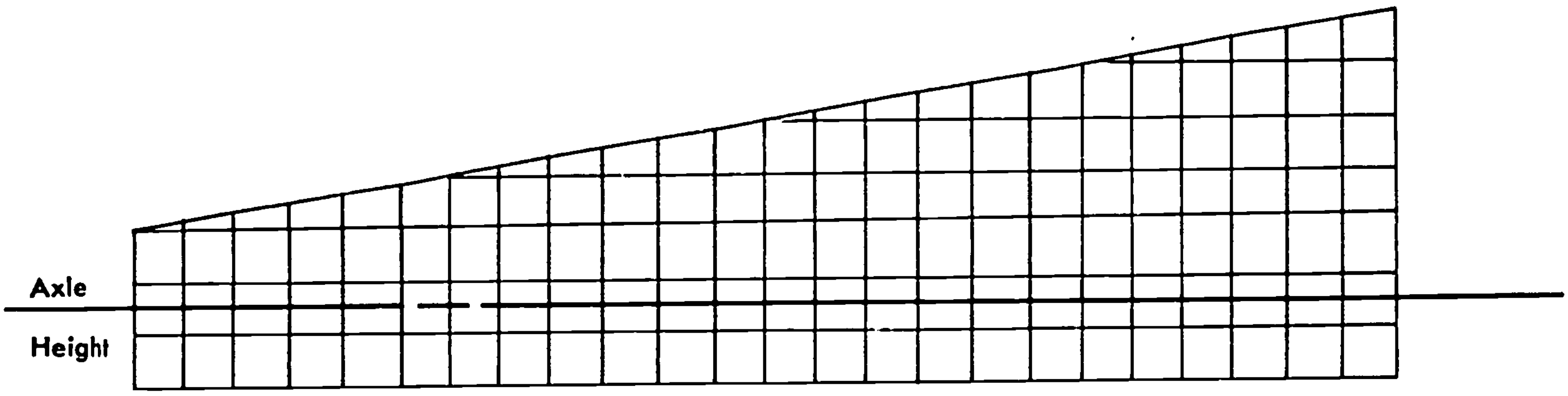
Period ______

Dwg. No. 100

Date ______

Fig. 20-1. Remove this Sheet from Teacher's Guide Draw left and right halves. Join both halves and duplicate full scale (¼" grid).





Left Half of Grid Sheet

Fig. 20-1. Remove this Sheet from Teacher's Guide

straightedge, French curves, and other needed mechanical guides. Show use of coins to draw small curves.

2. The designer chooses a promising sketch of an object and makes a *projection drawing*. He draws to scale. (Show Transparency 20, *Grid*. Draw a full-scale view on the grid, based on a selected rough from ACTIVITY 7A.)
3. The front view of the projection drawing can show the side of the object being drawn. *The front view has nothing to do with the front of the object. It is the view that shows the most detail.*
4. A projection drawing is made up of two or more views of the same object. Projection drawing is different from previous sketches you have made in which one view was enough.
5. The top view must show the object rotated 90° *toward* the observer. *It must be drawn exactly above the front view.* (Draw a top view on the transparency grid.)
6. Your drawings in today's activity are to be full scale: they will show the *exact size* and *shape* of the object. (Demonstrate the use of grid paper by using the transparency for the full-scale drawing.)

Note

The instructor may check any beginning drafting text for a more complete description of projection drawing.

Discussion (5)

Review the demonstration by posing the following questions:

1. How is *drawing* different from *sketching*? (Mechanical guides such as a straightedge and French curves are used.)
2. A *projection drawing* is made up of at least two views. What are they? (Front view, top view.)
3. What is a *top* view of an object? (It is what the viewer would see if he were facing the front of the object and turned the object *toward* him 90°.)
4. Where is the *top* view drawn? (Exactly above the front view.)

Laboratory Activity (30)

Today students will develop a *refined sketch* of their LSRAV into a full-scale drawing.

1. Have equipment, supplies, and group file folders ready for distribution.
2. Each student is to use his refined sketch from ACTIVITY 7A to draw a front view of the vehicle, in outline form, on the duplicated grid paper. (Students may need guidance on the use of French curves or coins to draw arcs.)
3. Have them draw a top view exactly above the front view.
4. Have students sign and date drawings in the lower, right-hand corner.
5. Have each group file its drawings and turn in the file folder.
6. Allow time to complete questions in the Laboratory Manual.

Homework

Reading 12, *Making Three-Dimensional Models*

Answers for Laboratory Manual

1. A drawing that shows at least two views
2. True
3. From the projection drawings

ASSIGNMENT 21, ACTIVITY 8A
READING 12

Making Three - Dimensional Models

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading about making three-dimensional models:
   a. List reasons why it would be important for the designer to have a mock-up of the interior of the Apollo Lunar Excursion Model (LEM).
   b. List some advantages and disadvantages which a product designer might obtain by showing a hard mock-up to future customers.

Discussion

2. Given a drawing of a Land Speed Record Assault Vehicle:
   a. Name the steps involved in making a paste-up.
   b. Name four materials which can be used in making a mock-up.
   c. State why drawings are needed to make a paste-up and why paste-ups are made.

Laboratory Activity

3. Given a full-scale drawing of a body design and necessary equipment and supplies:
   a. Make a template for each view.
   b. Transfer the pattern onto a foamed styrene block.
   c. Cut the block to shape, making a three-dimensional mock-up.

Time Schedule

5 Overview
10 Presentation and Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for for Demonstration

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

3 coping saws
3 pr. scissors
3 ball-point pens
2 X-acto® knives

Supplies (Each student)

1 block 2" x 3½" x 12" precut foamed styrene
1 roll masking tape
1 sht. carbon paper
1 file holder from ACTIVITY 7B
1 pc. 8½" x 12" card stock

Overview (5)

1. Yesterday you learned that *projection drawings* are made from refined rough sketches of an object. You drew full-scale front and top views of your Land Speed Record Assault Vehicle.
2. Today's reading described various kinds of *models* or *mock-ups* used in presenting design solutions.
3. I will show and explain samples of three *kinds of mock-ups* that are commonly used in industry.
4. In today's laboratory activity you will make a *paste-up* from the full-scale drawing of your LSRAV.

Presentation and Demonstration (10)

1. Along with sketches and data, "3-D" models or mock-ups are another stage in developing a product design. There are three basic kinds of mock-ups.
   a. *Paste-up* — the simplest kind. It is called this even when no pasting or gluing is needed. The *paste-up* is used in the early stages of designing.
   b. *Appearance mock-up* — an accurate model of the product. It shows more detail than the paste-up, but there are no moving parts.
   c. *Hard mock-up* — very well constructed. It is accurate in all details, and all moving parts work.
2. *Mock-ups* help the designer and others to picture the proposed design. A mock-up

may be made of any suitable material such as *paper* or *card stock, wood, clay,* or some kind of *plastic.*

3. In today's laboratory activity you will construct a *paste-up* from the full-scale drawing which you made in ACTIVITY 7B.
4. Material for the mock-up is first selected. You will use foamed styrene plastic. (Show the class a foamed styrene block.)
5. The designer makes patterns from the drawings. (Transfer two drawing views onto card stock, using carbon paper. Cut out the shapes from the card stock.)
6. The designer makes patterns from the drawing. (Transfer two drawing views onto card stock, using carbon paper. Cut out the shapes from the card stock.)
7. With a coping saw, the designer cuts around the pattern outline. (Cut as indicated; demonstrate how to hold the block gently in a vise while cutting. Be sure to leave outline showing after cut.)
8. The designer repeats these steps, using the other pattern piece on another surface of the block. (Draw and cut as indicated.)
9. The sawed-out block is a *paste-up*: *a simple kind of mock-up.*

Discussion (5)

1. What are some types of *materials* used in making a mock-up? (Wood, paper or card stock, plastic, and clay.)
2. Why is a *drawing* necessary to make a *mock-up*? (A drawing shows the sizes and shapes needed.)
3. Why is a *paste-up* made? (The shape and size of the product can be seen more easily than from the drawings and sketches.)
4. List the *steps* for making a *paste-up* from a drawing.
   a. Select paste-up material.
   b. Make pattern pieces from drawing.
   c. Transfer pattern to paste-up material.
   d. Saw or cut material to make paste-up.

Laboratory Activity (25)

Three-D models help the designer and others to visualize the proposed design solution. Today students will make a paste-up from a drawing.

1. Distribute the folders containing the projection drawings from ACTIVITY 7B.
2. Each student is to lay his drawing over a piece of card stock with carbon paper between. Then he will trace the front view and top view onto the card stock.
3. Students will cut the front and top view pattern pieces out of the card stock, using scissors.
4. Hand out precut foamed styrene blocks. See Fig. 21-1 for shape and size require-

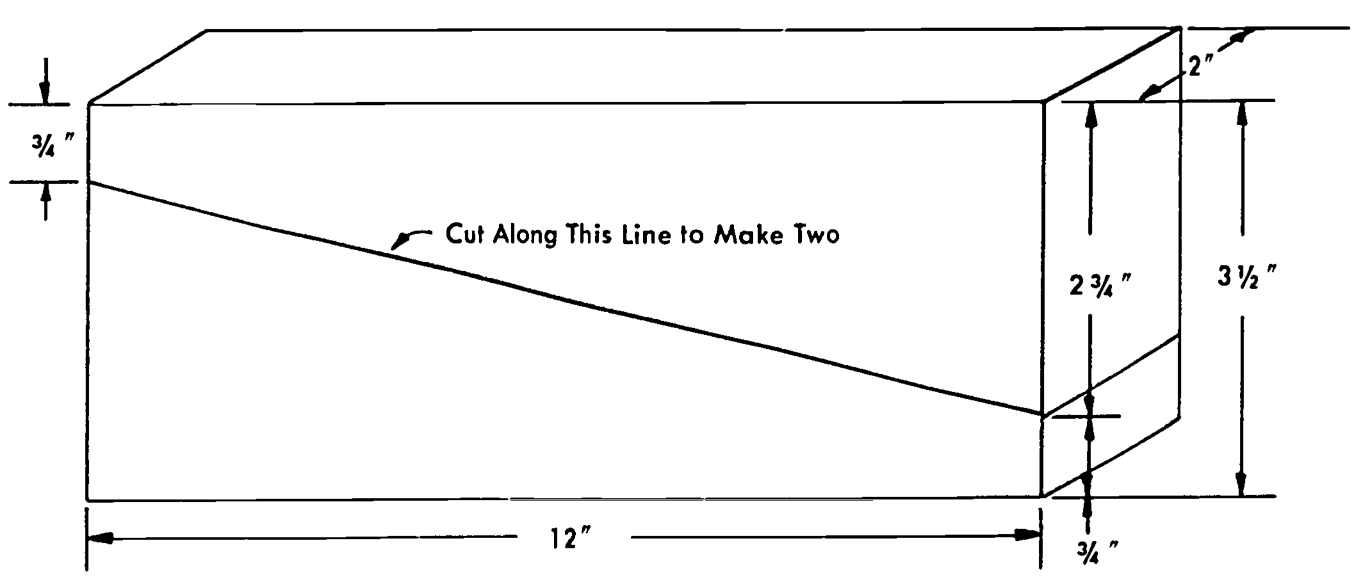


Fig. 21-1. Layout for Foamed Styrene Mock-Up

ments. Have students tape the front view of the LSRAV to the surface of the foamed styrene block and trace the outline onto the block with a ball-point pen.
5. Have students saw the vehicle to shape, using a coping saw.
6. Have the students repeat the procedure for the top view. Caution them to make sure the top view is taped onto the *bottom* of the block before tracing.
7. Have each student letter his name on the bottom of the mock-up and put it away.
8. Have each group put away the drawings and clean up their area.
9. Allow time to complete questions in the Laboratory Manual.

Safety Precautions
1. Coping saw blades have sharp teeth. Therefore they must be used with caution. Coping saws cut on the pull stroke.
2. Never force the saw through the material, but allow the teeth to cut through the material.
3. Be sure to make all cuts away from yourself.

Homework
None

Note

Add a few drops of liquid detergent (soap) to each bottle of tempera paints for use in ACTIVITY 8B to increase adhesion to styrene mock-ups.

Answers for Laboratory Manual
1. Wood; styrene or other plastic; clay; paper or cardboard.
2. a. To give the designer a feeling for the size, proportion, and scale of the design.
   b. They can be made quickly and inexpensively.
3. Answers will vary.
4. Work or move.
5. Hard mock-up.

Making Three-Dimensional Models

Objectives
As a result of their learning experiences, the students should be able to do the following:

Discussion
1. Given the terms "appearance mock-up" and "hard mock-up":
   a. State the difference between these types of mock-ups.
   b. State why hard mock-ups are made.
   c. Explain how hard mock-ups are different from the product they represent.

Laboratory Activity
2. Given the paste-up of the Land Speed Record Assault Vehicle from ACTIVITY 8A, refine the *paste-up* into an appearance mock-up.

Time Schedule
5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5	X-acto® knives
2	½″ paint brushes
5	artist's paint brushes, assorted sizes
2 pr.	scissors

Supplies (Group of 5)

5 btls.	tempera (water) paints, assorted colors, 2 oz. bottles
5 shts.	8½″ x 11″ construction paper, assorted colors
5	LSRAV paste-ups from ACTIVITY 8A
20	1⅝″ plastic wheels with ⅛″ axle holes *or* cut wheels from styrofoam
10 pcs.	⅛″ x 2½″ welding rod (for axles) *or* heavy coat hanger wire

1 file holder from ACTIVITY 8A
1 btl. white glue for repair

Overview (5)

1. To date you have designed a product, from thumbnail sketches through a *paste-up model*. You learned some of the procedures involved with each step of development.
2. Yesterday you shaped a rough mock-up of the LSRAV, technically named a "*paste-up*." It shows the height, width, and length of the product.
3. Today I will explain some of the characteristics of an *appearance mock-up* and *hard mock-up*. Then you will be asked to explain how hard mock-ups are used and how they are different from the product they represent.
4. In today's activity you will refine your paste-up of your LSRAV to an *appearance mock-up*, showing color and trimmings.

Presentation (5)

An *appearance mock-up* looks more like the finished product than any other stage of product designing we have reached so far. A *hard mock-up* is even more like the product.

1. *Appearance mock-ups* are finished to a higher degree than paste-ups. An appearance mock-up of a product shows greater detail than a paste-up. It may show color, texture, and trimmings. It is not always made of the same material as the final product, and it does not have moving parts.
2. A *hard mock-up* shows in detail what the product will be like. It is made of the same materials as the product. If there are to be moving parts, these parts will move in the hard mock-up.
3. Some hard mock-ups serve as *patterns* for making dies and tools for the product.
4. Most hard mock-ups do *not* have working parts such as gears and motors, but may have drawers that slide or other parts that move.

Discussion (5)

Review the presentation by posing the following questions to the students:

1. What are the differences between *appearance mock-ups* and *paste-ups*? (Appearance mock-ups show greater detail than paste-ups. They may show color, texture, and trimmings or decorations.)
2. How are *hard mock-ups* different from *appearance mock-ups*? (Hard mock-ups are more refined. They often have moving parts and are made of the same material as the product.)
3. Why are *hard mock-ups* made? (To show the product very exactly. As patterns for the product, to make tools and dies.)
4. What is the difference between a *hard mock-up* and the *product*? (A hard mock-up will not have working parts, such as motors.)

Laboratory Activity (30)

Today students will complete an *appearance mock-up* using a variety of materials to make it resemble their refined sketch from ACTIVITY 7B.

1. Have the equipment supervisors obtain the equipment and supplies.
2. Have the students *carve* their paste-ups to make them look like the refined sketches from ACTIVITY 7B and *sand* them smooth. Caution the students to observe safety precautions when carving with a sharp knife.

Note

A scrap piece of foamed styrene is excellent for smoothing the rough surface. Use it as you would files or abrasive paper.

3. Students are to paint or otherwise decorate their mock-ups to resemble the refined sketches in color and other details. Remind the students to spread newspaper on the work surface before using the paint. Have the timekeepers watch the time.
4. On clean-up signal, have each group recorder file the drawings and turn in the files. The appearance mock-ups should be returned to storage by the equipment supervisors. Have all students help with cleanup.
5. Have all students help clean up their work areas, supervised by the foreman.
6. Allow time to complete questions in the Laboratory Manual.

Safety Precautions

1. When you carve foamed styrene with a knife, the blade should always be directed away from your hand.

2. When painting your mock-up, be careful to keep the work area clean.

Homework

Reading 13, *Refining the Design Solution*

Answers for Laboratory Manual

1. An appearance mock-up is more refined; it shows more detail.
2. Dies and tools for the product.
3. A hard mock-up is not powered.

ASSIGNMENT 23, ACTIVITY 9
READING 13

Refining the Design Solution

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about refining design solutions:
   a. Name the types of people market research teams should interview before completing the design of a motorcycle.
   b. List a product and the reason you would have rejected it, if you had been asked about the product before it was manufactured.

Discussion

2. Given a product, construct four questions that a custom builder would ask the buyer.

Laboratory Activity

3. Given the appearance mock-up of the LSRAV from ACTIVITY 8B, refine the mock-up and complete the design solution.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5	X-acto® knives
2	½″ paint brushes
5	artist's paint brushes, assorted sizes
2 pr.	scissors

Supplies (Group of 5)

5	paper towels
5 btls.	tempera paints, assorted colors, 2 oz. bottles
5 shts.	8½″ x 11″ construction paper, assorted colors
1 btl.	white glue for repair of styrofoam
1	file folder from ACTIVITY 8B
5	LSRAV appearance mock-ups from ACTIVITY 8B

Overview (5)

1. During the past two days you have been working on a mock-up for your LSRAV. You have learned that mock-ups and models are three-dimensional ways to present a design solution.
2. Yesterday you completed your appearance mock-up using a variety of materials to make it resemble your refined sketch.
3. The text reading explained the importance of improving or refining the design solution. Two types of consumer surveys were described: the interview and the

54

panel discussion. You learned that data collected by a consumer survey are tabulated, evaluated, and used to make some logical decision about a product design.

4. Today I will tell you about consumer surveys and some of the factors to consider in finding out a consumer's preference.
5. You will be asked to suggest four questions that a custom builder might ask the buyer.
6. During today's laboratory activity you will have a chance to refine your mock-up of the LSRAV.

Presentation (10)

A consumer is someone who is likely to buy or use or "consume" a product. A consumer survey helps a product designer by giving him information about what people want to buy.

1. Consumer preferences or choices can be tested by conducting interviews or panel discussions.
2. Consumer survey information may be obtained from individuals or from groups.
3. In the development of custom-made vehicles, such as the LSRAV, an extensive consumer survey would not be necessary. However, the appearance mock-up would have to be presented to the buyer for his approval.
4. If the buyer requested it, the design solution would have to be modified.
5. Factors that could be changed in the design solution include:
   a. Styling
   b. Color scheme
   c. Distribution of body mass
   d. Location of engine

Discussion (5)

A consumer's answers to certain questions can provide information useful to the product designer.

1. What is the main question that is asked of the consumer (buyer), directly or indirectly? (Would you buy this product?)
2. Suppose the product is something like the LSRAV you designed. What questions would you, as the builder, pose to the buyer? (Open-ended question. Suitable responses might be: Does the product look stylish? Is the color scheme satisfactory? What other colors would you prefer? What would you add to the product to make it more suitable?)

Laboratory Activity (25)

This laboratory activity will permit students to refine their mock-ups and complete the design solution.

1. Students who have completed their appearance mock-ups may proceed with the refinement of their mock-ups.
2. Students who have not completed their appearance mock-ups may do so today, and then continue with ACTIVITY 9.

Safety Precautions

1. When you carve foamed styrene with a knife, the blade should always be directed away from your hand.
2. When you paint the mock-up, be careful to keep the work area clean.

Homework

Review of Readings 1 to 5 and 9 to 13 if optional Assignment 24 is used. If Assignment 24 is not used, there is no homework.

Answers for Laboratory Manual

1. Answers will vary. Styling, color scheme, distribution of body mass, etc.
2. Answers will vary.
3. Answers will vary.

ASSIGNMENT 24 (OPTIONAL)

Review 1

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the summaries of Readings 1-5 and 9-13, ask and answer questions about man and technology, the evolution of manufacturing, manufacturing and the economic system, manufacturing technology, manufacturing management technology, researching and developing, designing manufactured goods, creating alternate design solutions, and making three-dimensional models.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to select one of the following alternatives:

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking.
3. Have each group of students get together and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker, knowledgeable about management, research, or design to talk to the class. Schedule the speaker for the first class period and tape record his talk so it can be played to your other classes.
5. Schedule a field trip to a manufacturing plant to see activities related to the above readings.

Homework

None

ASSIGNMENT 25

Test No. 1

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 1, select responses from a list of items related to concepts presented in Readings 1 to 5 and 9 to 13.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Distribute answer sheets and have students fill out needed information.
4. Pass out test booklets. Caution students to keep them closed until you say "begin."
5. Read the directions for filling in answer blanks. Then direct students to open test booklets and begin.
6. Allow 35 minutes for completion. Collect answer sheets first; then test booklets, pencils, erasers, and eraser shields.
7. Review the test with students to provide feedback.

Homework

Reading 15, *Engineering the Product*

Note

Look ahead to Assignments 61 to 81 concerning Product and Process R & D. Start gathering ideas for possible simple products that can be designed, engineered, and mass-produced within about 18 periods. Thought should be given to utilizing some of the specialized equipment you have in your laboratory. Thought should also be given to student interest in selecting possible products. You should also consider the availability of materials. *The teacher will need to limit the constraints for the product so that students do not get embroiled with a too complex and difficult* product for the time available.

Answers to Test No. 1

1. B	2. D	3. B	4. B	5. D	6. A	7. D	8. B	9. A
10. A	11. B	12. B	13. D	14. B	15. D	16. B	17. C	18. D
19. B	20. D	21. C	22. B	23. C	24. D	25. B	26. C	27. A
28. C	29. C	30. A	31. B	32. A	33. B	34. A	35. C	

ASSIGNMENT 26, ACTIVITY 10
READING 15

Engineering the Product

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to engineering the product:
   a. Explain why writers, illustrators, and editors are needed to help prepare service manuals.
   b. Discuss what your father could do if the motor of his electric razor burned out *before* and *after* the warranty period ended.

Laboratory Activity

2. Given an activity concerning the fit of various size bearings on an axle rod:
   a. Attempt to fit each bearing on the axle.
   b. Measure the inside diameter of each bearing to the nearest $\frac{1}{16}$″.
   c. Measure the diameter of the axle to the nearest $\frac{1}{16}$″.
   d. Measure clearances.
   e. Record all measurements and analyze the data.

Time Schedule

5 Overview
15 Presentation
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 set Transparencies:
- 26-1. *Clearance Space between Two Parts*
- 26-2. *Two Kinds of Fixed Assembly*
- 26-3. *Classes of Fit for Land Speed Record Assault Vehicle*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 12″ rule, with 16ths marked
1 pr. inside calipers
1 pr. outside calipers

Supplies (Group of 5)

1 $\frac{5}{8}$″ I.D. washer (bearing)
1 $\frac{3}{4}$″ I.D. washer (bearing)
1 $\frac{7}{8}$″ I.D. washer (bearing)
1 1″ I.D. washer (bearing)
1 pc. $\frac{3}{4}$″ dia. x 12″ dowels (axles)

Overview (5)

1. You have studied the work of the *product design group*. They establish the *function* and *appearance* of a product.
2. Today's lesson concerns the *product engineer group*. Part of their job involves *allowances* and *clearances*.
3. I will show you some transparencies and explain the idea of fit.

4. Our discussion will deal with *minimum clearance*, or *allowance*, and tightness of fit between mating parts.
5. In the laboratory activity you will test the fit of various sized washers (bearings) on a dowel rod (axle). You will measure the clearance between each bearing and the axle and find tolerance limits for the bearing.
6. Later, when you engineer your Land Speed Record Assault Vehicle, this information will be helpful.

Presentation (15)

Some parts are designed to be assembled permanently, with no movement. Some are designed so that one part moves against the other when the product is in use. Some are designed so that one part can be adjusted to different positions, or replaced easily.

1. If assembled parts move against each other when the assembly is working, there is friction. Have students rub hands together — this makes heat and hands are harder to rub. To overcome the friction, some assemblies can be oiled. However, there still must be a planned space between the mating parts to allow the oil to seep between them.
2. Show Transparency 26-1, *Clearance Space between Two Parts*. The planned or intentional difference between two mating parts is a *clearance space*. On this drawing it is the difference between diameters A and B.
3. Show Blockout 1. *Maximum clearance* for these parts is the smallest permissible axle combined with the largest permissible bearing.
4. Show Blockout 2. *Minimum clearance* for these parts is the smallest permissible bearing combined with the largest permissible axle.
5. The minimum or smallest clearance space between two mating parts is also called *allowance*. The engineer plans this allowance in advance; it is part of the product design.
6. The engineer chooses the amount of allowance between two mating parts, depending on what the function of the parts will be. Show Transparency 26-2, *Two Kinds of Fixed Assembly*.
7. Some mating parts of the shaft (axle)- and hole-type are designed so that one can move on the other. The *inside* diameter of the hole must be larger than the *outside* diameter of the shaft.
   a. The shaft may travel back and forth. A piston and cylinder are designed for this kind of fit. This general type of fit may be called a *sliding* fit, a *running* fit, or a *running clearance* fit.
   b. The shaft may rotate. The shaft that connects bicycle handlebars with the fork turns freely inside a hollow framing piece.
   c. The fit between the moving part and the stationary part will be loose or snug, depending on how much clearance is provided.
8. Some shaft or rod parts are designed so that they can be fitted into a hole without special tools, but once they are assembled, the parts bind. A gear wheel is sometimes assembled onto a shaft this way. A set screw or a key may be used in this kind of assembly. It is known as a *wringing* fit or a *transition* fit. The outside diameter of the shaft is the same size as the hole, or *very* slightly smaller.
9. Some shaft-type parts are designed so that they can only be assembled by special means. The shaft is designed to be larger than the hole.
   a. The parts may be assembled by mechanical force. This is called a *drive* fit, a *force* fit, or a *press* fit.
   b. The parts may be assembled by chilling the shaft or by heating the piece containing the hole. This is a *shrink* fit.
   c. There is no movement between two parts that have been assembled by force-fitting or by shrink-fitting.
10. Show Transparency 26-3, *Classes of Fit for the LSRAV*. These are examples of fit as they relate to your LSRAV.
11. The acceptable amount of *tolerance or size variations* for one mating part depends on the clearance designed for the assembly. If it is important for two parts to fit very precisely (with very little space between them), then the tolerance will be very small for each of the individual parts.

Laboratory Activity (25)

Today's laboratory activity will aid the students in understanding *clearances*.

1. Divide students into groups.

2. Distribute equipment and supplies. Students are *not* to know in advance the size of the washers (bearings) and dowels (axles).
3. Students are to test the fit of each bearing on an axle.
4. They are to measure and record diameters and then clearances.
5. Based on the equipment, they are to answer questions.
6. Supervise the return of equipment and supplies to the appropriate place.

Answers for Laboratory Manual

1. A did not go on. B may or may not have gone onto the axle.
2. C and D
3. 1/8" and 1/4"
4. 7/8" and 1"
5. Yes

Homework

Reading 16, *Designing Power Elements*

ASSIGNMENT 27, ACTIVITY 11
READING 16

Designing Power Elements

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to the design of power elements:
   a. Discuss some of the safety features designed into your automobile to increase the safety factor.
   b. Discuss whether the electric-powered automobile will be more expensive to design and engineer than the present gasoline-powered automobile.

Laboratory Activity

2. Given a problem concerning the thrust of a CO_2 powered LSRAV of different weights:
   a. Fire the LSRAV against a letter scale.
   b. Record and plot the findings and interpret the graph.

Time Schedule

5 Overview
15 Demonstration
25 Laboratory Activity

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 postal scale (letter)
1 CO_2 cartridge-firing mechanism
3 basic wood shapes for LSRAV (each a different weight test vehicle). (Modify the original bearing test vehicles by sawing different shapes.)

Supplies (Group of 5)

5 3/4" x 2½" CO_2 cartridges
See *Note* under Laboratory Activity.

Overview (5)

1. Yesterday you worked with tolerances and fit.
2. The reading explained the responsibilities of a product engineer in designing power elements.
3. I will demonstrate how to measure and calculate the thrust of a CO_2 cartridge in a LSRAV model.
4. The five groups will measure the thrust of a CO_2 cartridge in LSRAV models of five different weights. The average thrust of each group's findings will be plotted on a graph.
5. You will be able to determine the thrust of your finished LSRAV from its weight, by reading this graph.

Demonstration (15)

1. Place a letter scale on its back with the dial up and the base against the wall or a step. See Laboratory Manual Fig. 11-1.
2. Put the LSRAV against the scale and insert a CO_2 cartridge. Place Laboratory Manuals next to each side of the car, so that the car will move freely between them.
3. Hold the car and have a student fire the CO_2 cartridge.
4. Immediately after firing, release the car and read the thrust on the scale. Record the thrust on the chalkboard. See Fig. 11-2.
5. Test-fire this car two more times. Add the three thrust measurements and divide the sum by 3 to find the average thrust. See Fig. 11-2.
6. Weigh the car on the scale with cartridge in place. Explain to students that they will record the weight and average thrust of their car in Fig. 11-3.
7. Have the students complete the speed curve graph in the Laboratory Manual.

Laboratory Activity (25)

Note

This activity can be modified to use only *five cartridges* per class. The teacher would demonstrate the firing again and have the students record the results on the chart. The chart should be used again after the actual prototype is completed.

Alternative

1. Each group of students is to test and calculate the thrust of a different LSRAV.
2. Ten minutes before the end of class have each group report its findings.
3. Plot the findings on the chalkboard. See Fig. 11-4. Emphasize the fact that the *lightest car* has the *greatest thrust* and *acceleration.*

Safety Precautions

1. Make sure that the CO_2 cartridges are stored in a cool place and are not jarred or bumped. Warm in hand before firing.
2. When test-firing the cartridges in the LSRAV, make sure that the car is held momentarily, then released.

Homework

Reading 17, *Making Working Drawings*

ASSIGNMENT 28, ACTIVITY 12A
READING 17

Making Working Drawings

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given an *assembly drawing* and a reading about making working drawings:
   a. Discuss how well your assembly drawing compares with the description of assembly drawings given in the text reading.
   b. List products in your home that are examples of a *single* piece of material, a series of assembled parts, and a system.

Discussion

2. Given the presentation, explain the use of each type of *working drawing* in engineering a product.

Laboratory Activity

3. Given the engineering requirements developed in ACTIVITIES 10 and 11, begin drafting a set of working drawings for a model of the LSRAV.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 Transparency 28, *Grid for Designing LSRAV*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5 12″ rules

Supplies (Group of 5)
5 copies drawing of LSRAV basic form, full scale, front and top views*
10 pcs. 8½" x 14" tracing paper (unlined)
1 file folder from ACTIVITIES 10 & 11
20 paper clips

*Note
See Fig. 20-1 in Teacher's Guide. Draw full size on ½" x 14" paper and duplicate.

Overview (5)

1. In the last assignment you learned that the *product engineer* is responsible for designing the power and transmission for a product.
2. During the laboratory activity you calculated the *thrust* of a carbon dioxide cartridge for different weight vehicles.
3. The text reading concerned working drawings. You learned that a set of *working drawings* provides all the information about a product needed to make it.
4. I will show you how working drawings are made.
5. You will be asked to state the kinds of information shown in assembly drawings, detail drawings, and parts lists, and to tell who prepares them.
6. During today's activity you will begin to draft a set of working drawings by making a *sketch* of the LSRAV.

Presentation - Demonstration (10)

Sketches, notes, and calculations are used to begin a set of working drawings. (Use the transparency overlays with your presentation.)

1. A set of working drawings provides all the information about a product needed to make it.
2. A set of working drawings typically includes an *assembly drawing* and *detail drawings*. It may also include *systems* or *schematic drawings*.
   a. Show Transparency 28, *Grid for Designing LSRAV*. An *assembly drawing* shows the product assembled or "put together". Often it shows front, top, and side views of the product. It may also show several sides of the product in one pictorial view.
   b. A *detail drawing* shows only one part of the product. (Point out the wheels.) There are usually as many detail drawings as there are different parts. Every part is given a name. It may also be identified by code letters or numbers. A detail drawing gives data about the exact shape and size of a part. The materials and the operations to be used in making the part may be shown with notes.
   c. A *systems drawing* or *schematic drawing* shows how the parts of a system are connected. For example, an electrical schematic drawing shows the wiring plan or *scheme* for circuits. Plumbing and hydraulic system may be shown on schematic drawings. Exact sizes and shapes are not needed on a schematic.
3. Show Transparency 28 again. A *dimension* is the exact distance between two points on a part, or on an assembly. On a detail drawing, information about dimensions is shown. If the shape of a part is complicated, many dimensions must be shown or *specified.* To show a dimension clearly, the draftsman usually enters the following on his drawing (discuss and locate dimensions as related to the class activity):
   a. A *numeral* to represent the required value or distance.
   b. An "inch" mark, "foot" mark, or other *symbol* to show the unit of measure. Sometimes this symbol is omitted.
   c. A *dimension line* to show the direction in which the value or distance will be measured.
   d. *Arrowheads* to show the two endpoints of the distance.
   e. *Extension lines.* These are used when the dimension line is placed outside the view.
4. A working drawing may be *full size* or *scaled.*
   a. On a full-size drawing, the distances between points on the drawing are the same as the distances or dimensions on the part.
   b. A drawing that is scaled *down* is smaller than the part it shows.
   c. A drawing that is scaled *up* is larger than the part it shows.
5. Working drawings must be very *accurate*. Precise curves, angles, and scaled dimensions are required. The draftsman uses many instruments in his work.
6. All the drawings in a set are numbered to identify them.

7. A complete *list of parts* or materials is prepared as part of a set of working drawings. This parts list may appear on the assembly drawing or may be on a separate sheet.
8. All drawings are signed by the draftsmen who made them and by technicians who check them.

Discussion (5)

A set of working drawings is made up of an assembly drawing, detailed drawings, and sometimes schematic or systems drawings.

1. What does an *assembly drawing* show? (All the parts assembled, or put together, to form the product.)
2. What does a *detail drawing* show? (One part of the product, and all dimensions of that part.)
3. What is a *parts list*? (A list of all parts used in building the product.)
4. What information is shown on a *parts list*? (The size, type, and quantity needed for each part.)
5. Who makes *drawings*? (Anyone with the knowledge and skills, but usually draftsmen and technicians.)

Laboratory Activity (25)

Today students will begin to prepare a set of *working drawings*. (**Note:** If there is not enough time today, the drawings may be completed in ACTIVITY 12B.)

1. Students are to use the engineering sketches and calculations from ACTIVITIES 10 and 11.
2. Provide each student with a duplicated copy of a drawing showing the front and top views of the LSRAV basic form. See Fig. 20-1 in the Teacher's Guide. Draw full size and duplicate. This will be Drawing 100.
3. On this drawing they are to sketch the front and top views, check dimensions, and darken the lines.
4. Each student is to make two tracings of his sketch, using a ruler or other straightedge to guide his pencil. The tracing paper should be paper-clipped to the sketch.
5. Have the students enter the title "LSRAV Body" under the sketch and first tracing, and enter the title "LSRAV Assembly" on the second tracing.
6. Have the students enter "DWG No. 100" on the basic sketch, "DWG No. 101" on the first tracing, and "DWG No. 102" on the second tracing.
7. Remind students to *sign* all drawings before filing them. This certifies the drawings.

Homework

None

Answers for Laboratory Manual

1. Assembly
2. Dimension
3. Dimension
4. Systems
5. Pictorial

Note

Look ahead to Assignments 31-34 and prepare Jigs and Fixtures 31-1, 31-2, 31-3. See Fig. 31-6.

ASSIGNMENT 29, ACTIVITY 12B

Making Working Drawings

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given the LSRAV drawings started in Laboratory ACTIVITY 12A:
   a. Make detail drawings of the wheels, axles, bearings, and screw eyes.
   b. Prepare an assembly drawing by adding parts to the LSRAV body.

Time Schedule

5 Overview
40 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5 12″ rules

Supplies (Group of 5)

1 file folder from ACTIVITY 12A with drawings
5 pcs. 8½″ x 14″ tracing paper
20 paper clips

Overview (5)

1. Yesterday you began a set of *working drawings* of the LSRAV.
2. Today you will add other components of the LSRAV to Drawing 101 and prepare a new *detail drawing*.
3. You will make an assembly drawing (Drawing 102) by drawing the wheels and other parts on the body.

Laboratory Activity (40)

The class will continue the set of working drawings begun in ACTIVITY 12A.

1. Each student is to obtain his sketch and tracings from his group's folder.
2. Students are to *sketch lightly on Drawing 101* the additional LSRAV parts shown in Fig. 12B-2 of the Laboratory Manual.
3. Have the students check their work with other members of their group, make any needed corrections, and *then darken* the lines.
4. Have the students trace the additions onto Drawing 102.
5. Each student is to draw or trace a wheel, an axle, a bearing, and screw eye between the views on Drawing 101. Show students how to draw *hidden lines*.
6. Remind students to label each part, under the view, and enter their name in the lower right-hand corner of the sheet. Have them add the date and DWG. No. beneath their name.
7. Have the students clip the drawings together, file them, and turn in their equipment.

Homework

None

Note

Look ahead to Assignment 31-34, and prepare Jigs and Fixtures 31-1, 31-2, and 31-3. See Fig. 31-6.

ASSIGNMENT 30, ACTIVITY 12C

Making Working Drawings

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given the working drawings made in ACTIVITIES 12A and 12B:
   a. Enter dimensions and notes on all drawings.
   b. Prepare a parts list for all parts shown in the drawings.

Time Schedule

5 Overview
10 Presentation
30 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 Transparency 28, *Grid for Designing LSRAV*, with overlays

Equipment and Supplies for Laboratory Activity

5 12″ rules
5 pcs. 8½″ x 11″ tracing paper

Overview (5)

1. You have been preparing *working drawings* of the LSRAV model.
2. Today I will review the dimensioning of drawings.
3. You will *dimension* all the drawings you have made, add the needed notes, and check your work for completeness.
4. You will also prepare a *parts list* for all parts shown in your drawing. This will complete your set of working drawings.

Presentation (10)

Review the principles of dimensioning discussed in ACTIVITY 12A, using Transparency 28, *Grid for Designing LSRAV*, with all overlays projected.

1. Dimension and extension lines should be lighter than object lines.
2. Extension lines begin 1/16″ away from the object.
3. Place dimension lines where they will be easy to read. Avoid confusion.
4. Try to avoid drawing one dimension line across another one.
5. Shorter dimension lines go between the object and longer dimension lines, when possible.
6. Leave ¼″ to ½″ space between an object and a dimension line. Also leave ¼″ to ½″ space between dimension lines.
7. Arrows should touch extension lines.
8. Print numerals and letters about ¼″ high.
9. Do not run dimension lines through numerals.
10. Do not over-dimension.
11. Enter all needed notes and identification numbers.

Laboratory Activity (30)

Today the students will *dimension* their drawings and *prepare a parts list.*

1. Students are to dimension all drawings except Sketch No. 100; they may practice on the sketch. Fig. 12B-1 and 12B-2 in the Laboratory Manual show all dimensions.
2. Each part should be numbered.
3. Have students check each other's work and make any needed corrections.
4. Each student is to draw and label a Parts List form, as shown in Fig. 12C-1 in the Laboratory Manual. This will be Drawing No. 103.
5. Students are to record parts numbers, descriptions, materials, quantities, and whether or not each part is to be purchased.
6. Each student is to sign and date his Parts List, clip it together with his other drawings, and return all drawings to the group folder.

Homework

Reading 18, *Building the Production Prototype*

Note

See Assignment 31 and precut stock prior to class for use in ACTIVITY 13A. It may also be helpful if students bring in shoe boxes for carrying and storing their LSRAV parts for the next few days.

ASSIGNMENT 31, 32, 33, 34
ACTIVITY 13A, B, C, D
READING 18

Building the Production Prototype

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to production prototypes:
   a. Discuss why management personnel or future consumers would want to examine prototypes of products before final designs are chosen.
   b. List reasons why the *field testing* of a prototype is the "greatest challenge that the prototype will meet."

Discussion

2. Given the term *production prototype,* explain in their own words what a production prototype is and state two uses it may serve.

Laboratory Activity

3. Given the necessary supplies and equipment, fabricate and assemble a production prototype according to a set of working drawings.

Time Schedule

Assignment 31
- 5 Overview
- 5 Presentation
- 5 Discussion
- 10 Demonstration
- 20 Laboratory Activity

Assignment 32, 33, 34
- 45 Laboratory Activity

Note

Prepare the following before class or have students do these operations in class:

1. Cut 2″ x 4″ pine stock to 12″ lengths. See Figs. 31-1 and 31-2.
2. Bore power plant housing, using Fixture 31-1 as shown in Fig. 31-3.
   a. Insert bit.
   b. Align and clamp fixture in proper location. See Fig. 31-3.
   c. Set depth stop at correct depth.
   d. Clamp with spring clamp and bore hole.

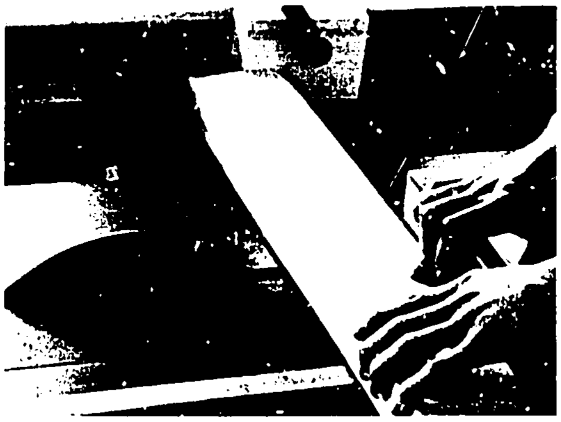


Fig. 31-1. Cutting 2″ x 4″ to Length

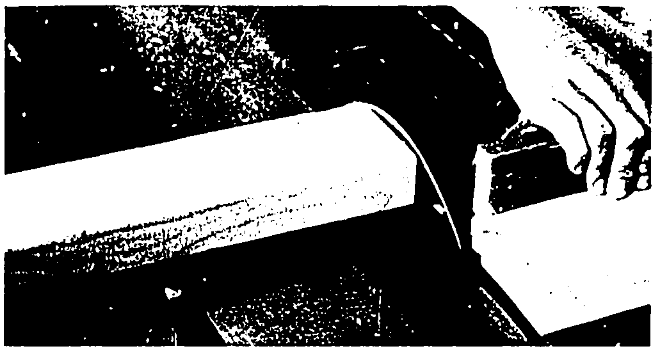


Fig. 31-2. Cut Completed

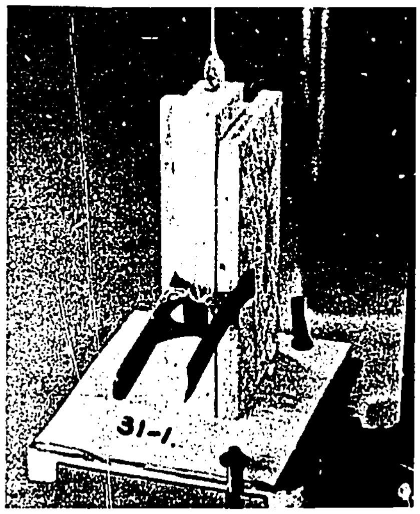


Fig. 31-3. Boring 3/4″ Engine Hole 2″ Deep
Bore both ends with holes opposite each other.

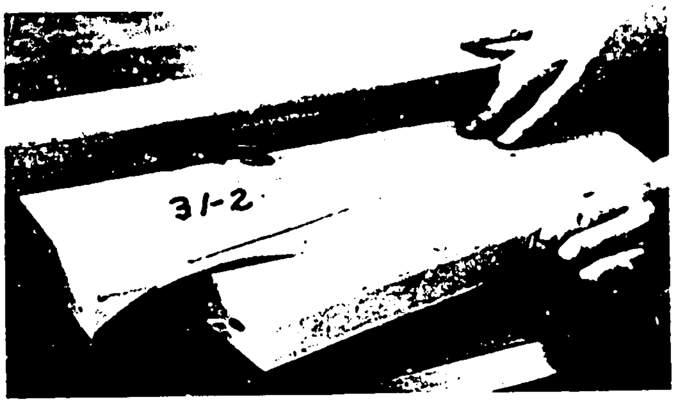


Fig. 31-4. Cutting the Taper on the Circular Saw Using Fixture

Fig. 31-5. Cut Completed
Note: The safety guard is removed to show a better view.

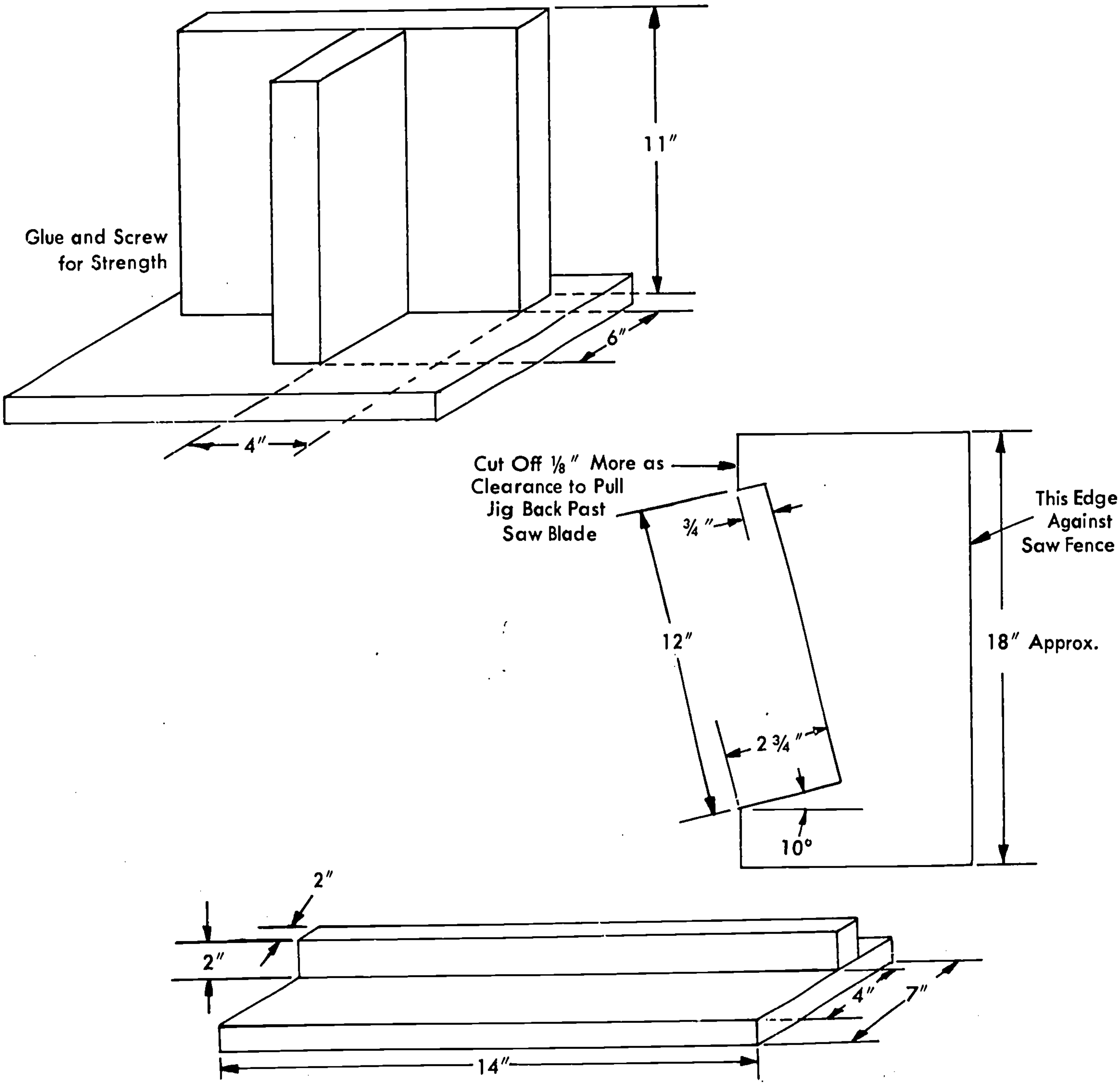


Fig. 31-6. Jigs and Fixtures

3. Cut taper, using Jig 31-2. See Figs. 31-4 and 31-5.

Equipment Needed by Teacher before Class

1 spade bit, ¾″
1 Drill Fixture 31-1 (See Fig. 31-6.)
1 spring clamp
1 circular saw
1 Taper Jig 31-2 (See Fig. 31-6.)

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1 bandsaw
1 drill press
1 Drill Fixture 31-3 (See Fig. 31-6.)
2 C-clamps

Equipment (Group of 5)

5 sets working drawings
1 half round wood rasp
1 half round cabinet file
1 3/16″ twist drill
1 utility knife
1 pr. pliers, side cutting
1 ball peen hammer
1 scratch awl

Supplies (Group of 5)

5 vehicle kits, each to contain the following:
- 4 #6 washers
- 1 block of wood (knot free) with power plant housing bored
- 4 wheels
- 1 welding rod *or* heavy coat hanger wire, ⅛″ dia. x 5¼″
- 1 waxed soda straw, ⅛″ I.D. 5/32″ O.D., 3″ long
- 2 screw eyes, ¼″ x ½″

5 shts. carbon paper, 4¼″ x 14″
5 shts. abrasive paper, medium
5 shts. abrasive paper, fine
1 can spray paint, white
1 set felt tip markers
10 thumbtacks *or*
1 btl. rubber cement for attaching pattern to block

Overview (5)

1. You have learned that a set of working drawings is needed to build the production prototype.
2. You have completed a set of working drawings for a Land Speed Record Assault Vehicle (LSRAV).
3. Today's reading told you about production prototypes and their uses.
4. Today and for the next two days you will be building a production prototype of your Land Speed Record Assault Vehicle.

Presentation (5)

1. A *production prototype* is a *full-scale working model* of a new product, built according to the *working drawings.*
2. One reason for making a prototype is to find out whether the parts called for on the drawings will actually fit and work together according to the designer's plan.
3. Often a complete prototype is made and tested before actual production begins. Sometimes only certain parts are fabricated and tested. More than one prototype is often made.
4. The prototype acts as a bridge between the plans and production.

Discussion (5)

1. What is a *production prototype*? (A full-size working model of a product.)
2. Why is a production prototype built? (To prove that the product can be made from the drawings and that it will work according to the designer's plans.)

Demonstration (10)

1. Demonstrate drilling the axle and engine holes housing. Use Drill Fixture 31-3.
   a. Insert a block into the drill fixture, flush against the stop.
   b. Align to proper location and drill.
2. Demonstrate cutting the basic shape on the bandsaw.

Laboratory Activity (20, 45, and 45)

Students have three activity periods to complete the prototype.

Tentative Time Schedule

1. Assignment 31: Drill engine holes and cut front view to shape on bandsaw.
2. Assignment 32, 33: Drill axle holes, file, and sand.
3. Assignment 34: Coat, finish, and assemble prototype.

Safety Precautions

1. Keep fingers away from cutting edges of the drill.
2. Wear safety glasses.

Homework

None

ASSIGNMENT 35, 36
ACTIVITY 13E, F
(13F OPTIONAL)

Building the Production Prototype

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given a production prototype, test its *performance* by *timing* a test run and *calculating speed.*

Time Schedule

Assignment 35
- 5 Overview
- 5 Presentation
- 35 Laboratory Activity

Assignment 36
- 45 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1 start/finish gates w/tether lines
1 stop watch
1 postal scale, calibrated to show weight in ounces

Supplies (Student)

1 prototype vehicle
1 CO_2 cartridge

Overview (5)

1. You have learned about *production prototypes,* how they are made, and the purpose they serve.
2. Today you will *test* the production prototype you made.

Presentation (5)

1. A production prototype is tested for two purposes: (a) to see if the product *can* be built, and (b) to see if it will *work* satisfactorily.
2. A prototype can be tested under two types of conditions: (a) *laboratory* or *simulated* conditions, and (b) *actual* or *field* conditions.
3. Testing under actual conditions means that the prototype undergoes the same kind of use that is intended for the production model.

Laboratory Activity (35)

1. Have start/finish gates set up and both tether lines strung. Tension on tether lines can be achieved by moving start/finish gates. See Figs. 35-1 to 35-11 and Figs. 35-13 to 35-17.
2. The test track may be 40′, 50′, or 60′ long. See that all firing pins are adjusted to the same pin length for penetration. The larger the hole, the more gas that is released. All holes should be equal. Discard cartridges after use.
3. Distribute cartridges only at time of test. Cartridges should be at *room temperature.* Hot cartridges have greater power; cold cartridges have less power. They should be equal.
4. The teacher should choose launch control personnel or operate the launch control himself. *Screw eyes* may need to be opened just a little to allow for *quick* "tethering" and release.
5. Students should obtain "weight" by weighing the vehicle, *with* a cartridge on a postal scale. Students can estimate thrust by referring to previously developed speed curve chart.
6. Give help as needed in using the stop watch. Two students might time all test runs. If one lane tends to be slow, check the firing pin penetration. Compare hole sizes in the spent cartridges.
7. Laboratory Manual Fig. 13E-1 is a table to be used for finding scaled speed.
8. After a student finds the scaled speed for his model LSRAV, he is to complete a Performance Certificate, Fig. 13E-2.
9. Using information gathered from the trial test firings, the teacher can construct a Speed Graph as follows:
   a. Weigh heaviest and lightest LSRAV's (with cartridge) in each class and one or two in between.
   b. Using the formula $V = \frac{2 \times \text{Distance}}{\text{Time}}$ and MPH $= V \times .68$, construct a Speed Graph, *or* divide the scaled speed in Fig. 13E-1 by 12 to get the MPH.
   c. The Speed Graph can be used to show the relationship between weight and

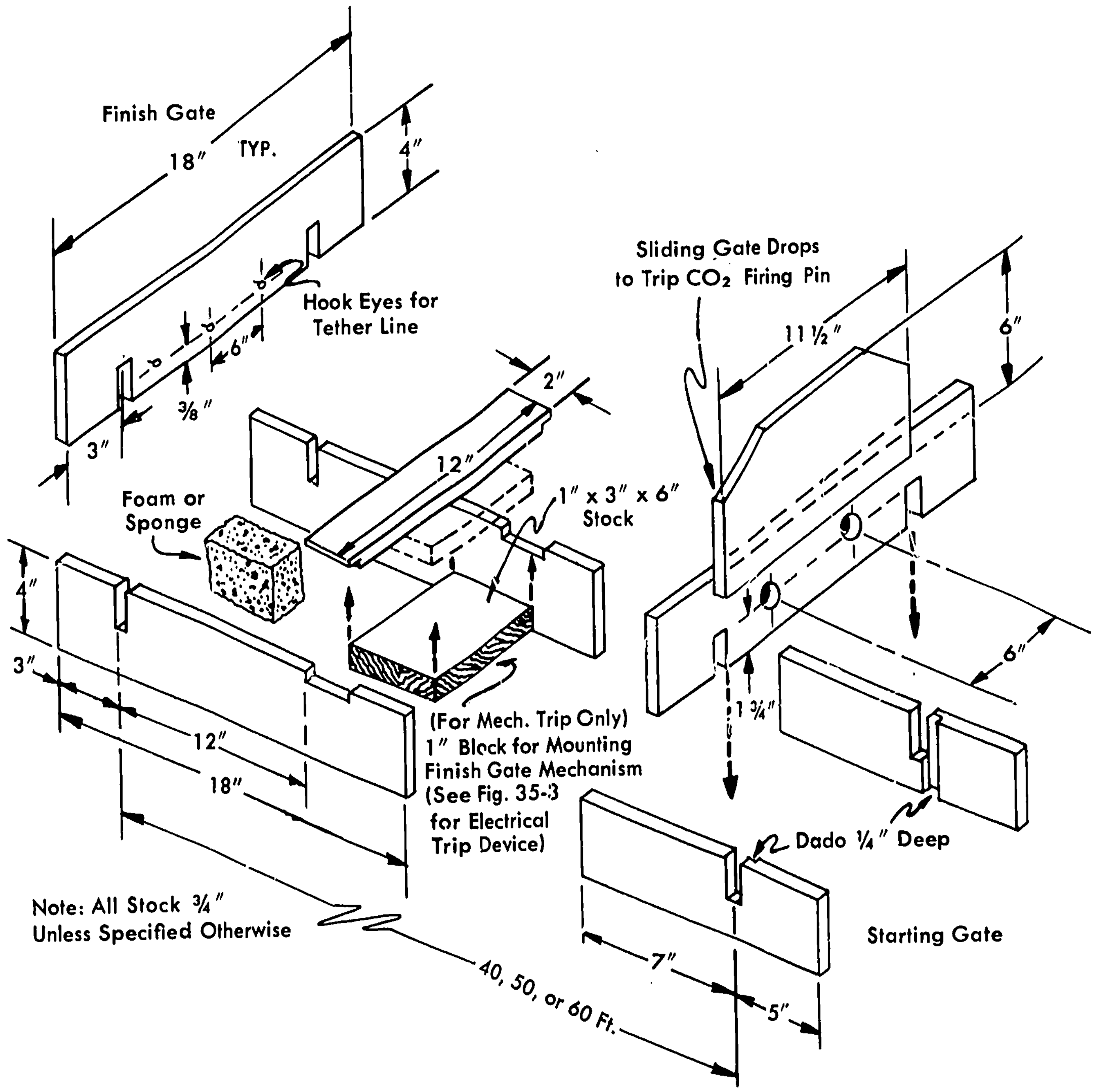


Fig. 35-1. Start-Finish Gate Assembly

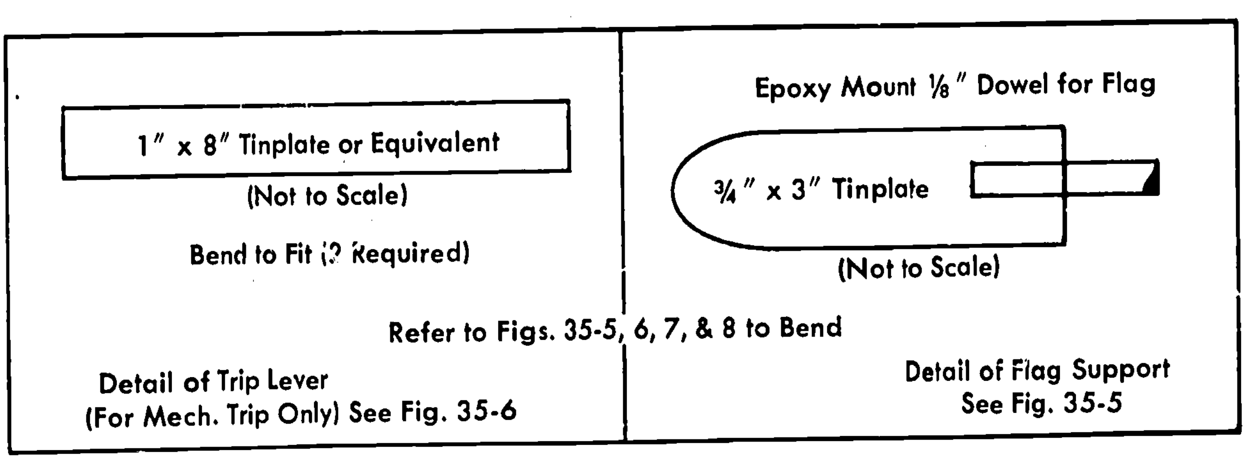


Fig. 35-2. Mechanical Trip Detail

speed. It can also be used the next year to more accurately predict speeds based on the weight of the LSRAV (with cartridge).

Safety Precautions

1. The teacher should control distribution of CO_2 cartridges. Hand out cartridges at the start gate only at the time of each race.
2. Explain the danger of altering CO_2 cartridges in any way.
3. Make certain that vehicles are "threaded" to tether lines and lines are clear.

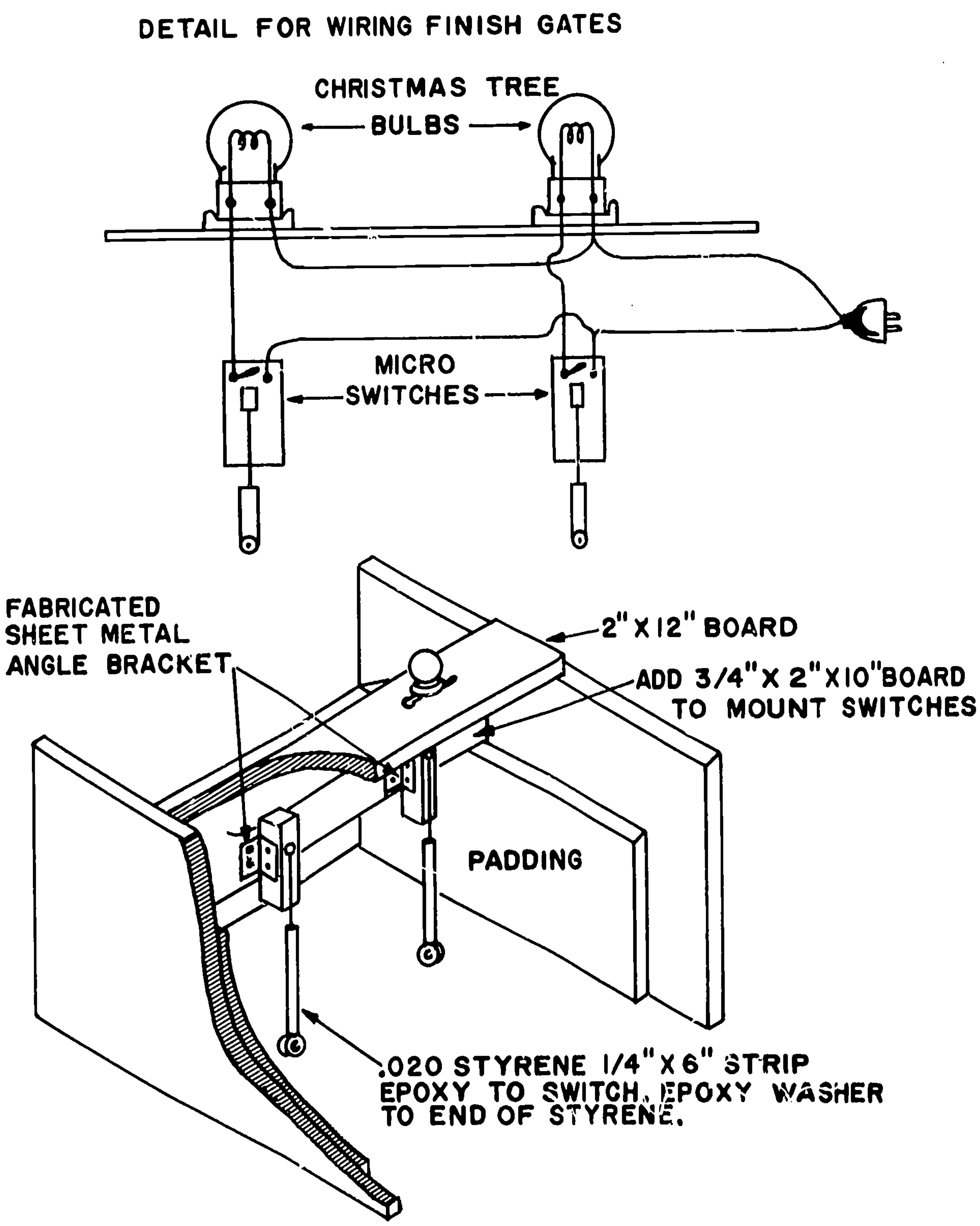


Fig. 35-3. Electrical Trip-Mechanism Schematic and Assembly

70

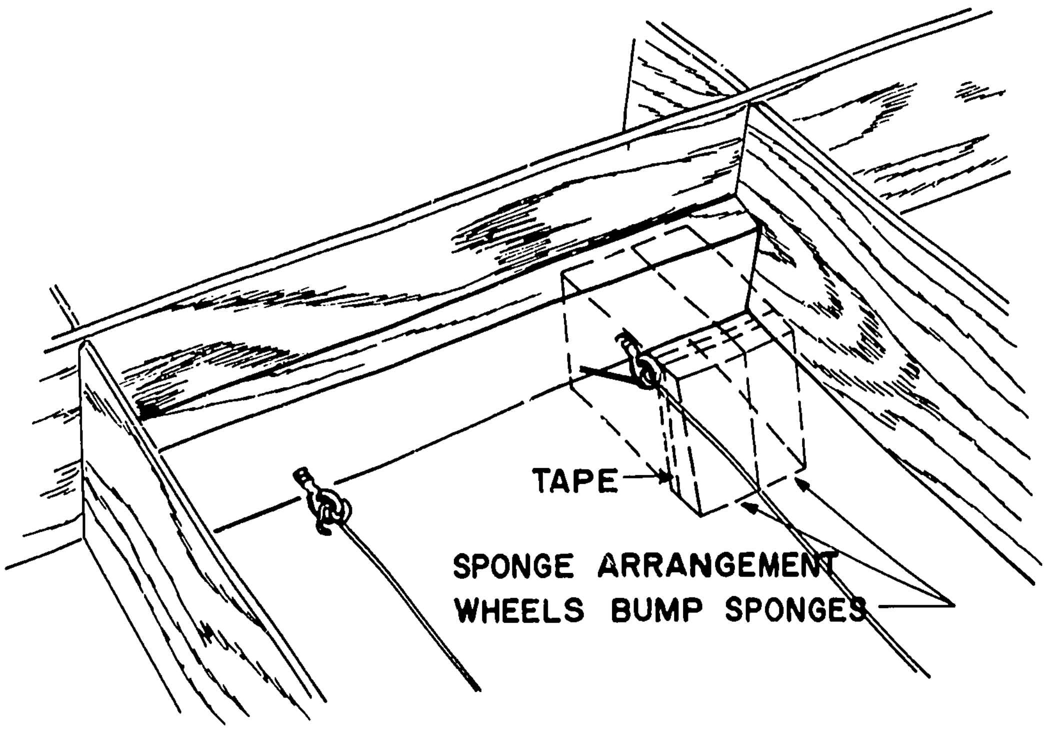


Fig. 35-4. Finish Gate Tether-Line Detail and Sponge-Stop Arrangement

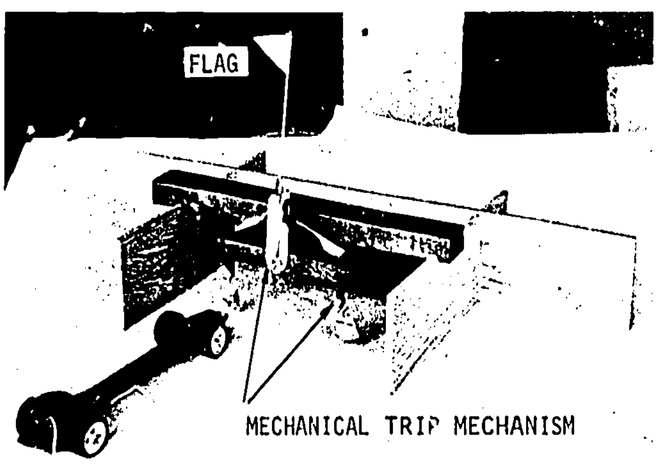


Fig. 35-5. Mechanical Trip Mechanism and Flag

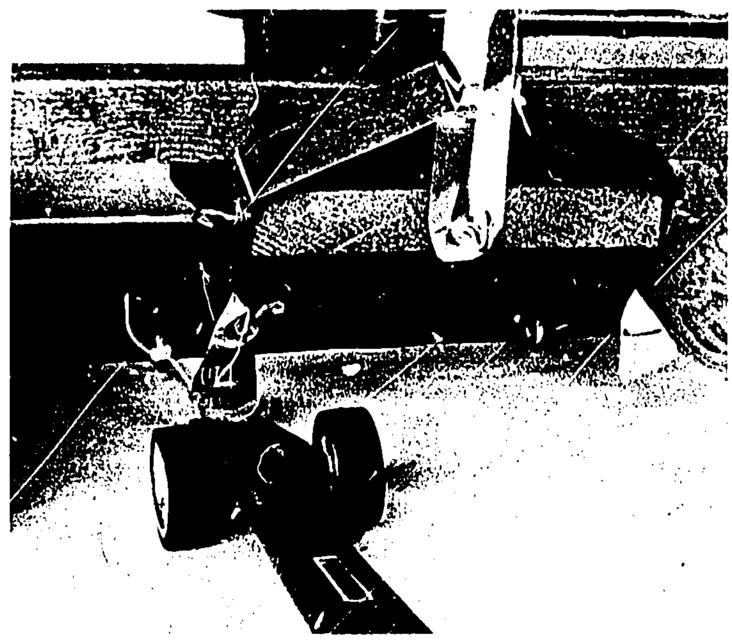


Fig. 35-7. Mechanical Trip Mechanism and Tether Line

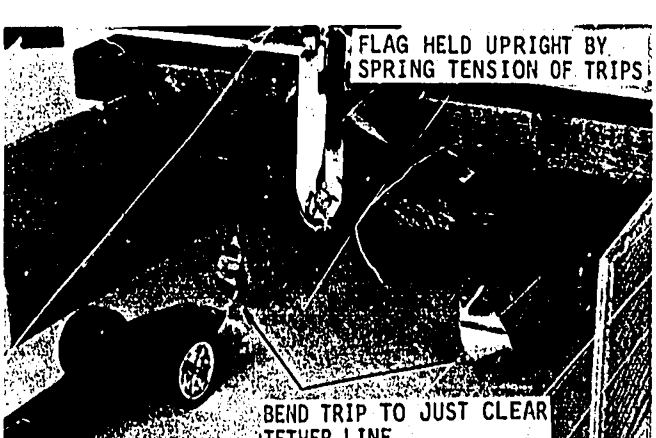


Fig. 35-6. Mechanical Trip Mechanism Detail

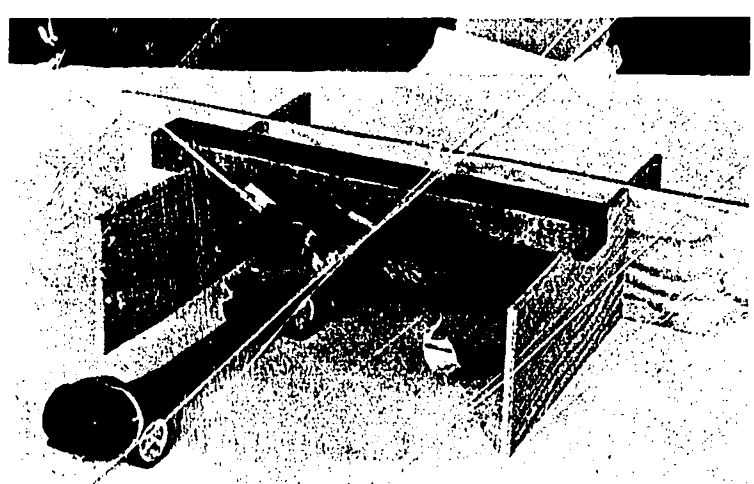


Fig. 35-8. Mechanical Trip Action

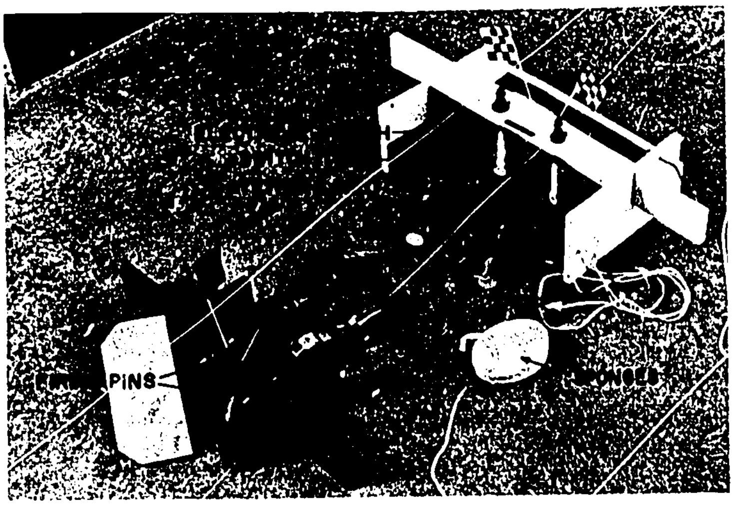


Fig. 35-9. Start-Finish Gates with Electrical Trips

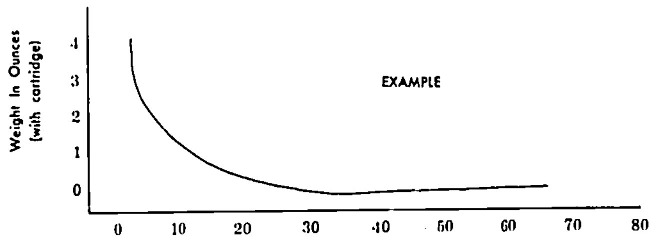


Fig. 35-12. Speed Graph

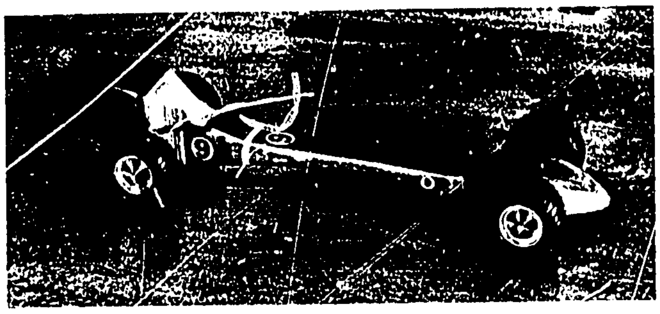


Fig. 35-13. Model LSRAV

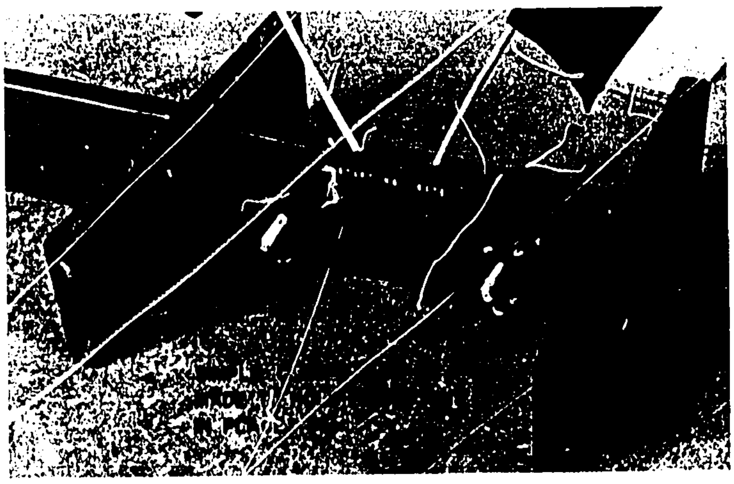


Fig. 35-10. Starting Gate Detail of Firing Pins and Tether Hooks

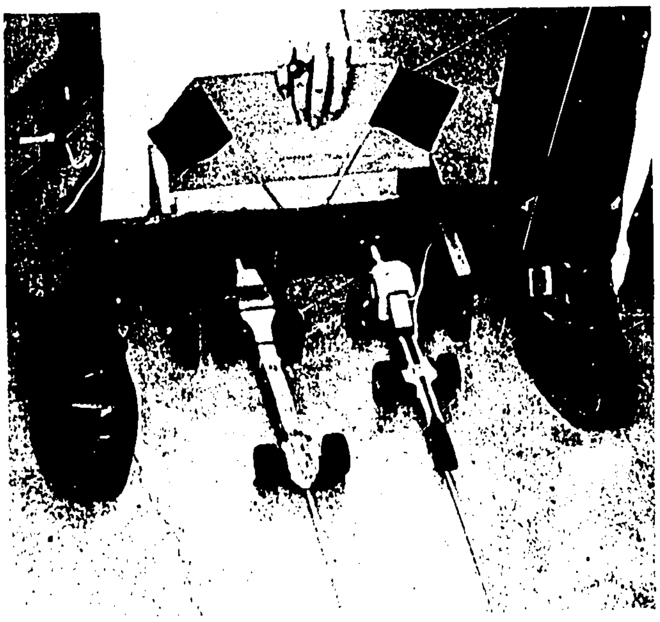


Fig. 35-14. Starting Gate Ready for Firing

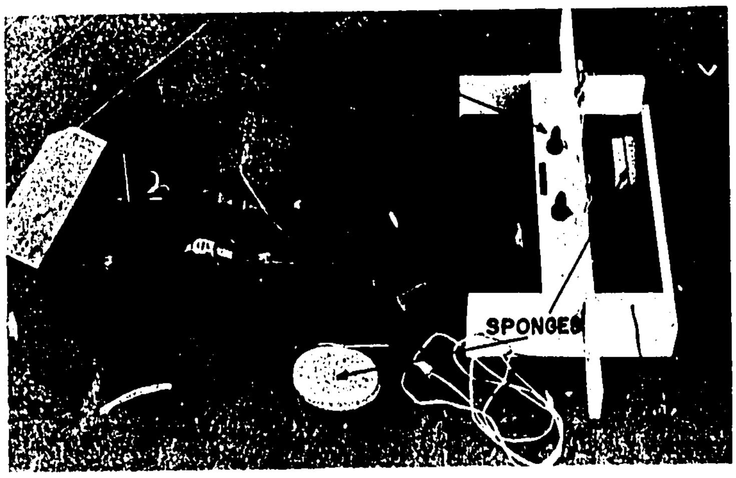


Fig. 35-11. Start-Finish Gates Showing Firing Pin Locations

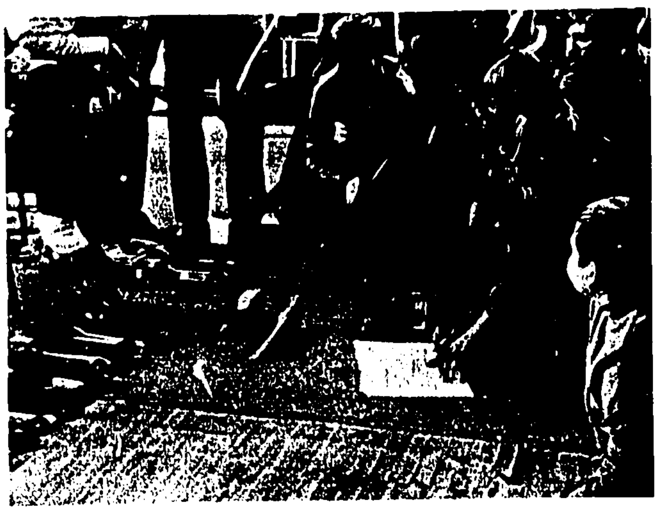


Fig. 35-15. Firing

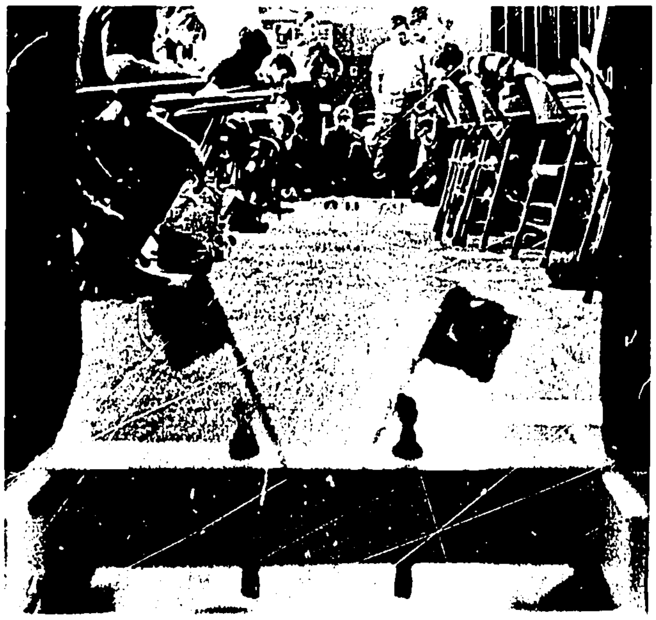


Fig. 35-16. Test Track

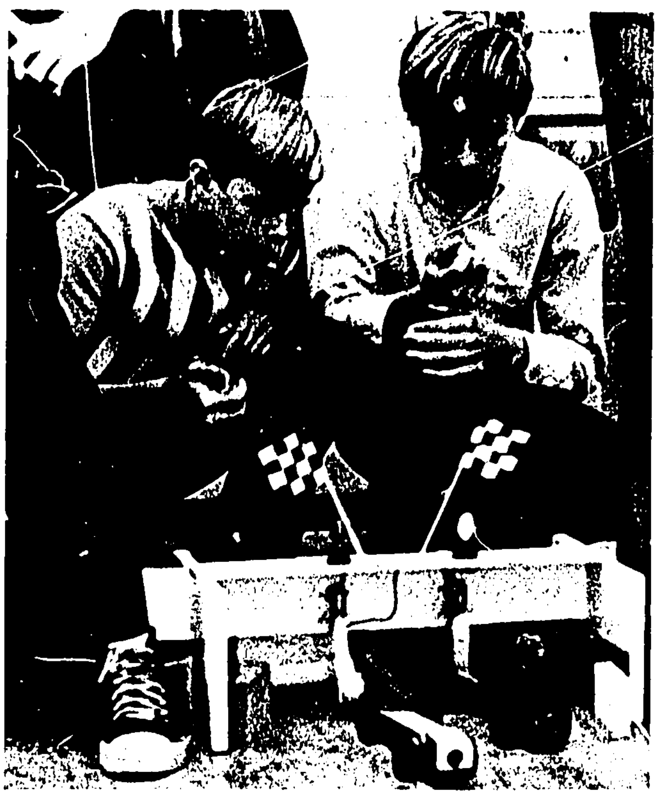


Fig. 35-17. Timing at Finish Gate

Homework

Reading 19, *Technical Writing and Illustrating*

Note

You may want to take polaroid photographs of the LSRAV's and include them in the service manual in the next activity.

ASSIGNMENT 37, ACTIVITY 14
READING 19

Technical Writing and Illustrating

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a service manual and warranty for a household appliance:
   a. Determine if the instructions and illustrations in the service manual are easy for you to read and understand.
   b. Examine the warranty and list information from the warranty related to the household appliance.

Discussion

2. Given the term "instruction manual," state how such a manual is useful to a consumer and name some examples of manuals found around the home.

Laboratory Activity

3. Given an exploded pictorial view of the Land Speed Record Assault Vehicle and pertinent data, prepare an instruction manual containing a view of the LSRAV, specifications, and assembly and operating instructions.

Time Schedule

5 Overview
5 Presentation - Demonstration
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5	12″ rules
1	stapler
1	triangle
1	protractor *or* French curve
1	Polaroid camera w/film (optional)

Supplies (Group of 5)

25 shts. 8½" x 11" paper
1 file folder from ACTIVITIES 13A-F
1 set colored pencils *or* felt markers
5 drawing pencils

Overview (5)

1. Yesterday the LSRAV prototypes were tested and speeds were calculated.
2. The text described technical writing skills, the kinds of jobs that require these skills, and reasons for writing specifications and instruction manuals.
3. I will review some concepts mentioned in the text and clarify the items that go into manuals.
4. You will be asked to name some of the ways in which a consumer uses instruction manuals.
5. In the laboratory activity you will prepare an instruction manual for your LSRAV, using material provided and adding to it according to your own ideas.

Presentation - Demonstration (5)

Technical writing and illustrating have many uses. One important function is to describe a product to the person who will use it and repair it.

1. *Instruction sheets, catalogs,* and *manuals* explain how to use a product properly.
2. *Maintenance manuals* explain the care of the product; for example, lubricating the parts and troubleshooting.
3. *Technical writers* and *illustrators* produce the writing and illustrations for manuals, instruction sheets, and catalogs. The illustrators may have specialized training in drafting, art, or both.
4. Manufacturing personnel from other departments often work with the writers and illustrators who prepare manuals.
5. For products such as household appliances and toys, the language of the writing is kept simple so that consumers who do not have an extensive background can understand it.
6. The illustrations may be of a mechanical drawing type such as isometric views, or they may be shaded perspective sketches and photographs.
7. *Guarantees* and *warranties* protect the consumer against faulty products:
   a. A guarantee usually states the manufacturer's lawful responsibility for the operation of the product.
   b. A warranty is typically a pledge of a product's quality, backed by the integrity of the manufacturer.

Discussion (5)

An instruction manual tells the consumer the proper way to *operate* and *maintain* the product.

1. What are some important uses of manuals? (To explain how to use and maintain the product. To tell a consumer how to troubleshoot for malfunctioning. To point out any dangers in operating the product. To explain how to put the product together or take it apart.)
2. Name some products that might be found around the home, for which manuals are needed. (Automobile, washer, dryer, toys, lawnmower, etc.)

Laboratory Activity (30)

Today the students will prepare an instruction manual for the LSRAV.

1. Each equipment supervisor is to secure all equipment and supplies for his group.
2. Students are to study the Laboratory Manual Fig. 14-1, Exploded View of Land Speed Record Assault Vehicle. Their drawings should be similar, but should show the LSRAV's they designed.
3. Call attention to the new aspects of today's drawing: center lines, reference numbers in circles, leaders, and the general idea of an exploded view. Give help as needed.
4. Students also will prepare a specifications sheet and operating instructions.
5. If time permits, they may design and illustrate cover sheets. If a Polaroid camera is available, they may incorporate photos of their LSRAV's.
6. Have students assemble their finished manual sheets and staple them. The group recorders will then gather the manuals and return file folders to storage.
7. Allow time for answering the questions in the Laboratory Manual.

Safety Precaution

Be careful when distributing and working with pointed instruments and tools.

Homework

None, or review Reading 10, *Designing Manufactured Goods*

Answers for Laboratory Manual

1. Writers, illustrators
2. Consumers or repairmen
3. To translate technical ideas into common, everyday language.
4. On the Parts List

ASSIGNMENT 38, ACTIVITY 15
READING 10

Designing Manufactured Goods

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a demonstration of the design process:
   a. Recall the common name for preliminary sketches.
   b. State that preliminary ideas are developed into roughs.
   c. Explain how a rough is refined.
   d. State the purpose of a mock-up.

Laboratory Activity

2. Given the problem of designing salt and pepper shakers to specifications:
   a. Make thumbnail sketches of design ideas.
   b. Develop three rough sketches.
   c. Refine the best rough sketch.

Time Schedule

5 Overview
10 Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Demonstration

Supplies

1 softwood block, $1\frac{1}{4}'' \times 1\frac{1}{4}'' \times 6''$ (hard mock-up of a design solution for a salt and pepper shaker)

Equipment and Supplies for Laboratory Activity

Supplies (Group of 5)

15 shts. $8\frac{1}{2}'' \times 11''$ white paper
5 colored pencils *or* felt markers, assorted colors
5 shts. $8\frac{1}{2}'' \times 11''$ tracing paper
1 file folder

Overview (5)

1. We have just completed a study of *researching, designing, and engineering practices* related to a *product.* For the next few weeks, we will be studying the *researching, designing, and engineering practices* related to *processes.* The first step in studying processes is to *identify a product to process.*
2. You have learned that the product designer develops various kinds of sketches and mock-ups to help him study and evaluate possible solutions to a problem. In earlier activities you designed a LSRAV.
3. Today I will review the steps that a designer follows as he creates alternate design solutions.
4. You will be asked about the steps followed by the industrial designer in developing a product design.
5. In the laboratory activity you will develop design ideas for salt and pepper shakers — the product. We will be *researching, designing, and engineering the processes* necessary to produce the salt and pepper shakers.

Demonstration (10)

In this demonstration a design will be developed from the thumbnail sketch through the hard mock-up stage.

1. Many simple sketches, called *thumbnails,* start the product design. On the chalkboard sketch several salt and pepper shaker design ideas. Sketch quickly using a very simple style. See Laboratory Manual Fig. 15-2.
2. *Rough sketches* are developed from a few "thumbnail" ideas. Show on the chalkboard how a very crude "thumbnail" is resketched, keeping its idea but developing it into a recognizable rough sketch. Also show how to "pick up" part or all of a sketch by laying tracing paper over a drawing and tracing whatever is worth copying. See Laboratory Manual Fig. 15-2.
3. Of the possible roughs, a single design seems to hold the most promise. The designer then makes a *refined sketch* of this selected design. See Fig. 15-2 in Laboratory Manual.
4. Mock-ups of the refined sketch are made, ranging from paste-ups through hard mock-ups, for appearance and for testing. A mock-up helps to visualize actual size and shape. Show the prepared block of wood that is a mock-up of the salt or pepper shaker.

Discussion (5)

To review today's presentation, pose the following questions to the students:

1. What are the preliminary sketches of a design idea called? (Thumbnail sketches.)
2. How are these preliminary ideas developed further? (They are resketched to show more detail, but still in rough form.)
3. How is a rough sketch refined? (It is traced or hand-copied. Color may be added to show trimming or decoration.)
4. What is the purpose of a mock-up? (To give an idea of the general shape and bulk of the design solution.)

Laboratory Activity (25)

Today the students will follow the design process from thumbnail sketch, through rough sketches, to a refined sketch of salt and pepper shakers.

1. Prepare the supplies for distribution to the groups of five.
2. Each student will make rapid, simple thumbnail sketches of design ideas for the salt and pepper shakers. Ask for simple sketches. Let each student sketch in any manner which is comfortable to him.
3. Working from thumbnail sketches, they will develop the first rough sketches. Then, on additional sheets of paper, they will try other designs, recording all their ideas.
4. Next, each student will sketch or trace to produce a refined rough. They may use tracing paper to "pick up" parts of several designs.
5. Each may color or decorate his refined sketch according to his own ideas, using colored pencils or felt markers.
6. Have the group members compare designs and choose one outstanding design within each group.
7. Each student will sign and date his sketch in the lower right-hand corner.
8. Each recorder will collect and file sketches, turn in the file folder, and give the best design to the teacher.
9. Allow time to complete the questions in the Laboratory Manual.

Note

Before tomorrow's class, make mock-ups of designs chosen by students. Laboratory ACTIVITY 16 is based on selecting one mock-up from a group.

Precaution

Care should be taken in tracing, because tracing paper is thin and will tear easily.

Homework

Reading 14, *Obtaining Approval of Management*

Answers for Laboratory Manual

1. Thumbnail sketches.
2. Rough.
3. Make a paste-up or other mock-up.
4. To make sure all of the possibilities are investigated.

ASSIGNMENT 39, ACTIVITY 16
READING 14

Obtaining Approval of Management

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading about obtaining the approval of management:
   a. Discuss how decisions would be made in a small company.
   b. Determine what information you would want to get from your product design staff before *you decide* on the product design for next year's automobiles.

Discussion

2. Given a presentation:
   a. Name several departments that provide advice while a product is being designed.
   b. State how a company decides whether to release a design for production.

Laboratory Activity

3. Given a product design created in ACTIVITY 15, represent management or stockholders in a discussion of whether to accept or reject the design.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Supplies (Group of 5)

1 file folder from ACTIVITY 15
1 *mock-up, based on design chosen by this group in ACTIVITY 15

*The teacher will need to prepare these in advance.

Overview (5)

1. The text reading described the various steps management follows *before a design is approved for production.*
2. I will talk about how a *decision to produce a product* is reached.
3. In today's discussion, you will be asked to name departments that give advice to the product designer and to state how a company decides whether or not to produce a product.
4. During the laboratory activity, you will discuss whether to accept or reject a design for salt and pepper shakers. One man (the teacher), acting on the advice of his assistants (students), will make the final decision.

Presentation (5)

Use the chalkboard to outline the key points of this presentation.

1. While a product is in the design stage, many meetings are held. People who are in charge of *designing, engineering, market research, sales, and production* may take part in some meetings.
2. The designer may *modify or refine his design several times* if experts from the various departments suggest ways to make it better.
3. When the designer believes that the product design is ready, he presents it to management for approval. A meeting of top management people is held, to *accept or reject* the design. *Accepting* the product design means *releasing it for production planning.* A *rejected* product design may be *dropped* or sent back for *further study* and changes.
4. At the final meeting the designer presents his design solution. Often he displays a hard mock-up of the product, showing in detail how it will look. He points out desirable features.
5. A production expert (teacher) gives advice as to whether the product can be made with equipment already on hand, and whether there will be serious production problems.
6. A marketing expert reviews what is known about the expected market for this product.
7. Other top management people may be asked for information.
8. The top manager alone makes the final decision to accept the final product design and release it for production, or to reject the design. He gets advice from his most

expert assistants before making this decision, but he alone decides.

Discussion (5)

1. While a product is being designed, the top people from several departments are expected to provide special advice. What are some of these departments? (Design, engineering, market research, sales, and production.)
2. How does a company reach the decision to make a product, and who decides? (The top manager and several experts attend a formal meeting. A product design is presented and discussed. Several management people may express their opinion, but the top manager makes the final decision.)

Laboratory Activity (30)

Today the students will represent management or stockholders at a meeting to accept or reject a product design.

1. Choose three students to represent management. One of these, the president, will make the final decision at the close of the meeting.
2. You, the teacher, will be the production expert. When you are called on to speak (Step 6) keep in mind that production of the chosen design must be feasible for these students using available equipment.
3. Assign the role of product designer to a student whose design was chosen by his group in ACTIVITY 15.
4. Seat management and the designer around a table in front of the class. Place a mock-up of the chosen design in full view on the table.
5. The designer begins by describing the features of his design.
6. The production expert will explain how the features of this design would make it easy or difficult to produce.
7. Have the management group question the design features.
8. Allow the stockholders to comment on the feasibility of producing this design. Explain that stockholders in a large corporation might not have this privilege.
9. The design and production experts should try to assure the president of the success of the product.
10. If the president decides to accept the design, have the participants sign and date one Design Release Form (per class), and remove it from the Laboratory Manual.
11. If the design is rejected, assign the role of product designer to another student and proceed as before until a design is approved.
12. Have the students return the mock-up and the completed Design Release Form to you. File the completed form and the refined sketch of the chosen design.

Homework

Review Reading 17, *Making Working Drawings*

Note

Before beginning ACTIVITY 17, the teacher will need to prepare a transparency overlay for each class, showing and dimensioning the special features of the accepted designs for each class. These designs could also be sketched on the chalkboard.

ASSIGNMENT 40, ACTIVITY 17
READING 17

Making Working Drawings

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the presentation, explain the kinds of information that are found on a set of working drawings.

Laboratory Activity

2. Given the salt and pepper shaker design solution accepted in ACTIVITY 16:
   a. Complete the views of the working drawing.
   b. Dimension the drawing, add notes, and complete the title block.

Time Schedule

5 Overview
10 Presentation - Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

Equipment

1 overhead projector/screen

Supplies

1 Transparency 40, *Salt and Pepper Shakers,* with overlay

Note

On the blank overlay, the teacher should sketch the design features approved in ACTIVITY 16 and dimension them with a color transparency marker.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5 12" rules

Supplies (Group of 5)

5 pcs. 8½" x 11" tracing paper
1 file folder from ACTIVITY 15
20 paper clips

Overview (5)

1. The textbook reading explained that many people in manufacturing work from plans called *working drawings.* A set of working drawings may include detail drawings, schematic or systems drawings, and assembly drawings.
2. I will show you examples to help you better understand the differences among the various kinds of drawings.
3. You will be asked to explain each kind of drawing in our discussion.
4. In the laboratory activity, you will prepare a set of working drawings for a salt and pepper shaker based on a design "approved by management" in ACTIVITY 16.

Presentation - Demonstration (10)

Show Transparency 40, *Salt and Pepper Shakers,* with the presentation.

1. Yesterday you obtained the approval of management for the production of a salt and pepper shaker design. The next step is to *develop a set of working drawings,* based on this design.
2. A set of working drawings must provide *all the information needed* to make a product. The working drawings you prepare for salt and pepper shakers will show exact *sizes, shapes,* and *materials.*
3. A typical set of working drawings includes an *assembly* drawing and *detail* drawings. It may also include *systems* or *schematic* drawings.
4. (Show Transparency 40 with overlay in place.) A working drawing often shows *front, top,* and *side* views of the product. It may also show several sides of the product in one *pictorial* view.
5. A *dimension* shows the exact distance between two points on a part or on an assembly. If the *shape* of a part is *complicated,* many dimensions must be shown. To show a dimension clearly, the draftsman usually enters the following on his drawing:
   a. A *numeral* to represent the required *value or distance.*
   b. An "inch" mark, "foot" mark, or other symbol to show the *unit of measure.* Sometimes this is omitted.
   c. A *dimension* line to show the direction in which the value or distance will be measured.
   d. *Arrowheads* to show the endpoints of the distance.

e. *Extension* lines. These are used when the dimension line must be placed outside the view.

6. A working drawing may be full size or scaled.
   a. On a *full size drawing*, the distances between points on the drawing are the *same as* the distances or dimensions on the *part*.
   b. A drawing that is scaled *down* is *smaller* than the *part* it shows.
   c. A drawing that is scaled *up* is *larger* than the *part it shows*.
7. Working drawings must be very *accurate*. Precise curves, angles, and dimensions are required. The draftsman may use many instruments in his work.
8. *Each* drawing in a set is *numbered* so it can be identified.
9. A complete *list* of parts or *materials* is prepared as part of a set of working drawings. This parts list may appear on the *assembly drawing* or may be on a separate sheet.
10. Every drawing is *signed* by the draftsman who makes it and by the technicians who check it.

Discussion (5)

A set of *working* drawings is made up of an *assembly* drawing, *detail* drawings, and sometimes *schematic* or *systems* drawings.

1. What is an assembly drawing? (A drawing that shows all the parts assembled, or put together, to form the product.)
2. What is a detail drawing? (A drawing of one part of the product, with all dimensions of that part shown.)
3. What is a materials list? (A list of all parts and materials used in the total product.)
4. What information is shown on a materials list? (The size, type, and quantity needed for each part.)
5. Who makes drawings? (Anyone with the knowledge and skills, but usually draftsmen and technicians.)

Laboratory Activity (25)

Today students will begin to prepare a set of working drawings.

1. Leave Transparency 40 with overlay projected on the screen for reference.
2. Have students sketch the special features of the chosen design on Laboratory Manual Fig. 17-1. Give help as needed.
3. Have the students *check* their sketched details with other members of their group, make any needed *corrections*, and *darken* the lines.
4. Each student is to trace the design, using a rule or other straightedge to guide his pencil. The tracing paper should be paper-clipped to the sketch. Be sure each student enters all the accepted design features on his tracing.
5. Students are to enter the *dimensions that give the location* and size of the design features as shown on the overlay.
6. Students should now enter the *basic dimensions and notes* as shown on the overlay.
7. Each recorder should collect his group's drawings, while the equipment supervisor returns the equipment.

Homework

Reading 20, *Planning Production*

Note

2″ x 4″ shorts — scraps from the Construction laboratory which have been ripped down are excellent for the next two activities. They do the job nicely and *save money*.

Note

The drawings for the salt and pepper shakers, and the supply lists on subsequent days, specify only "wood stock" for the shakers. The choice of wood is left to the teacher. You may prefer that your students use hardwood, softwood, or both. The counterboring fixture and drilling jigs should be made at this time. Install the 1/8″ metal drill jig to the fixture. Figures 40-1 and 40-2 are suggestions for jig and fixture setups.

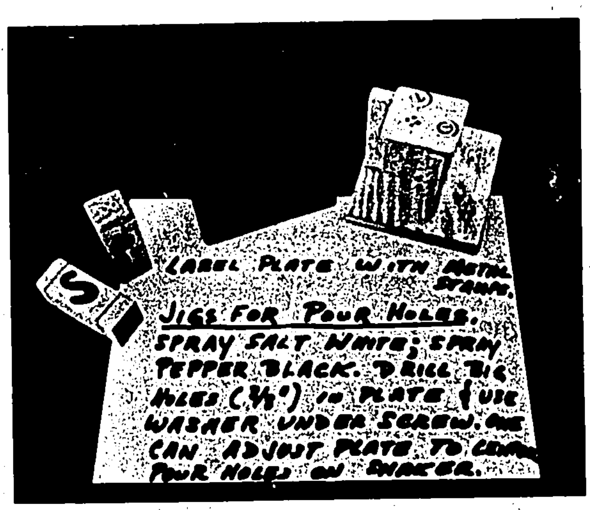


Fig. 40-1. Jig for Pour Holes

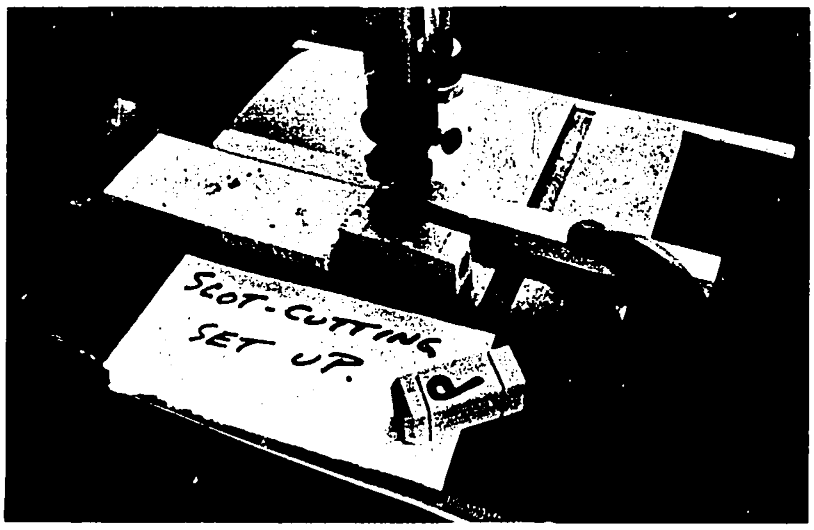


Fig. 40-2. Example Fixture for Cutting Slots

ASSIGNMENT 41, 42
ACTIVITY 18A, B
READING 20

Planning Production

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to planning production:
   a. Give reasons why manufacturing companies *cannot* plan their production of products using the trial and error method.
   b. State why large manufacturing machines are built only to special order.

Laboratory Activity

2. Given the supplies and equipment and a demonstration of processes, manufacture a salt shaker by *hand processes*. By so doing, begin building the production prototype.

Time Schedule

Assignment 41
5 Overview
40 Demonstration

Assignment 42
45 Laboratory Activity

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for the class to demonstrate the procedure they will follow. ALSO, GET THE EQUIPMENT AND SUPPLIES LISTED IN ASSIGNMENT 43.

Equipment and Supplies for Laboratory Activity

Equipment (Class)

6	12″ rule
4	crosscut saw
2	brace
1	$\frac{3}{4}$″ auger bit
1	$\frac{1}{2}$″ auger bit
1	hand drill
1	salt Drilling Jig No. 41-1, $\frac{3}{32}$″ holes
1	$\frac{3}{32}$″ twist drill
4	$\frac{3}{4}$″ x 2″ x 4″ sanding blocks
1	$\frac{1}{2}$″ finishing brush

Supplies (Class)

2	$1\frac{1}{4}$″ x $1\frac{1}{4}$″ x 48″ pine
1	soup can
1 pt.	clear lacquer
1 pt.	lacquer thinner
4 shts.	fine abrasive paper
	newspapers

Overview

1. Yesterday you developed a set of working drawings for the salt and pepper shakers.
2. Today I will demonstrate the hand and machine processes you will use to make the salt and pepper shakers.
3. In the next activity, you will perform these processes to begin building the production prototype.

Demonstration (40) (Assignment 41)

1. Demonstrate cutting off stock with a crosscut handsaw. (Do not demonstrate measuring and layout.) Have students follow along the processes in their Laboratory Manuals.
2. Demonstrate *counterboring* with a *brace and bit.*
3. Demonstrate *boring* with a *brace and bit.*
4. Demonstrate *drilling* with the *hand drill.*
5. Demonstrate *sanding* with *abrasive paper* and a sanding block.
6. Demonstrate *finishing* with a finishing *brush* and clear *lacquer.*
7. Remind the students after each demonstration that cutting, counterboring, boring, and sanding are chip removing processes which are separating practices.
8. Remind the students that finishing is a coating process which is a combining practice.
9. Explain that these concepts will be studied in detail later in the year.
10. Demonstrate *cutting off stock* in the miter box.
11. Demonstrate *counterboring* in the drill press.
12. Demonstrate *boring* in the drill press.

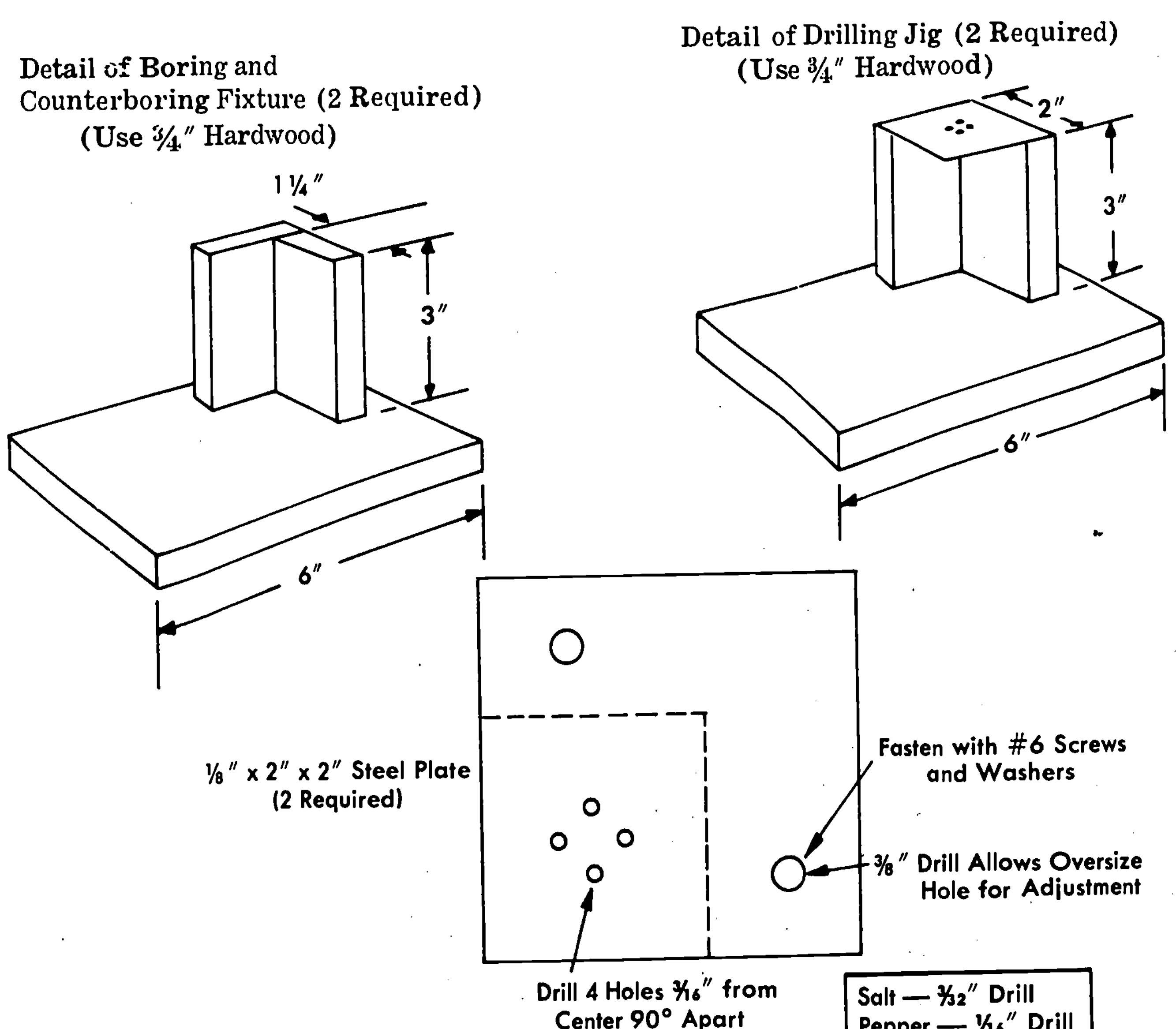


Fig. 41-1. Jigs and Fixtures

13. Demonstrate *drilling* with the electric hand drill.
14. Demonstrate *sanding* on the disc or belt sander.
15. Demonstrate *finishing* using an aerosol can of clear acrylic lacquer.
16. *Stress the importance of safe operation of machines.*
17. Remind the students that they will still be doing chip removing processes which are separating practices and a coating process which is one combining practice. Explain that these concepts will be studied in detail later in the year.

Laboratory Activity (45) (Assignment 42)

Today the students will manufacture a salt shaker using hand processes.

1. Move about the room, observing the activities of each student, and answer questions.
2. Monitor safety procedures of the students.
3. From making the working drawings yesterday, the students should be able to figure out how to lay out for cutting, boring, and drilling. Do not show them how. This should make the lesson on operation sheets more meaningful when you get to it.

Safety Precautions

1. Stock should be clamped securely.
2. Keep your hands clear of the saw and drill cutting edges.

Homework

None

Note

1. Prepare jigs and fixtures for ACTIVITY 18C. (See Fig. 41-1.)
2. Set up miter box with stop block.
3. Set up drill presses with jigs and feed stops.
4. Set up hand drilling stations.
5. Set up spray finishing station.
6. If you anticipate a bottleneck at the miter box tomorrow, build one for each group and use crosscut saws.

Answers for Laboratory Manual

(Answers will vary.)

1. Use a miter box with stop-block, etc.
2. Use a drill press, forstner bit, drilling jig, etc.
3. Use a drill press, forstner bit, drilling jig, etc.
4. Use an electric hand drill, drilling jig, etc.
5. Use a disc sander, belt sander, etc.
6. Use spray lacquer, etc.
7. Answer will vary.
8. No.

ASSIGNMENT 43, ACTIVITY 18C

Planning Production

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given the supplies and equipment, manufacture a pepper shaker using machines, jigs, and fixtures. By so doing, finish building the production prototype.

Time Schedule

5 Overview
40 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

5	miter boxes with stop-blocks
5	crosscut saws
2	drill presses
1	counterboring fixture (teacher-made)
1	boring fixture (teacher-made)
2	C-clamps
1	3/4" forstner bit *or* spade bit
1	1/2" forstner bit *or* spade bit
1	spring clamp
1	electric hand drill
1	pepper Drilling Jig No. 41-2, 1/16" holes
1	1/16" twist drill
1	belt *or* disc sander with fine sandpaper

Supplies (Class)

2	1 1/4" x 1 1/4" x 48" pine
1	spray can clear acrylic lacquer
1	cardboard box
	newspapers

Overview (5)

1. Yesterday you used hand processes to manufacture a salt shaker.
2. Today you will use machines, jigs, and fixtures to manufacture a pepper shaker.
3. As a result of this activity, you will have finished building the production prototype.

Laboratory Activity (40)

Today the students will manufacture a pepper shaker using machines, jigs, and fixtures.

1. Supervise the activities and answer questions when necessary.
2. Take special note of the safety precautions followed by the students.

Safety Precautions

1. Students using the power equipment should use safety glasses.
2. Check the dust-collecting system of the power sander to see that it is working properly.

Homework

None

Answers for Laboratory Manual

1. By hand processes.
2. Using machines, jigs, and fixtures.
3. Answers will vary.
4. Yes.

Note

Answers for Shaker Block Comparison Chart will vary. Pepper shaker block column *should* show more "yes" answers.

84

Planning Production

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the term "operation sheet":
   a. Describe how the industrial engineer uses it to plan or improve production.
   b. Describe how and when operation sheets are prepared.

Laboratory Activity

2. Given one of *six processes* to be used in manufacturing salt and pepper shakers, prepare an *operation sheet* for that process.

Time Schedule

5 Overview
15 Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 Transparency 44, *Operation Sheet*

Overview (5)

1. During the past two days, you have experimented with various manufacturing processes while you produced your production prototypes.
2. Today, you will examine these processes to determine what operations are done in each one.
3. Using this knowledge, you will write an operation sheet which is a tool used by management.

Presentation (15)

After choosing the best way of performing each *production process*, the engineer prepares *operation sheets* that describe in detail how each process is to be performed.

1. The selection of the best way is an early step in planning or improving production. (Refer to the last two laboratory activities in which students selected the best techniques from among alternatives.)
2. *Operation sheets* are used to identify *what must be done.* An operation sheet is a written description of how a process is to be performed.
3. Show Transparency 44, *Operation Sheet.* Explain each part of the operation sheet and what kind of information is recorded in each part.
4. The idea of operation sheets or charts was introduced in the reading on Planning Production.
5. When an operation sheet is to be prepared for a process, the process is performed and *each operation* or work task is *analyzed in detail.*
6. Develop the operation sheet on Transparency 44 by calling for answers from the students about some operation with which they are familiar. For example, develop the operations for washing hands, bending a coat hanger, etc. See Fig. 44-1.
7. Think about how much easier it would have been to manufacture the salt and pepper shakers if you had used operation sheets.
8. Operation sheets tell not only *what* is to be done, but *how* to do it.

Discussion (5)

Today the management tool known as the "operation sheet" was introduced.

1. How does the industrial engineer use an operation sheet in planning or improving production? (To record in an organized way the work tasks required, sequence of work, and the equipment requirements.)
2. When are operation sheets prepared? (During the planning of production.)
3. How are operation sheets prepared? (The process is performed and the operations involved are analyzed in detail.)

Laboratory Activity (20)

Today students will develop *operation sheets* for *six production processes.*

1. Explain that each group is responsible for preparing an operation sheet for its assigned production process.
2. Move from group to group, answering

questions and giving directions as required.

3. If additional time is available, conduct a class discussion of the operation sheets prepared by each group.

Homework

Reading 21, *Planning Processes*

Fig. 44-1. Sample Operation Sheet

Process to Be Analyzed: Sharpening a Pencil

Step	Description of Operation	Hand Tools	Machine Tools
1	Pick up pencil.		
2	Insert pencil in sharpener, hold.	pencil sharpener	
3	Turn handle on sharpener.	pencil sharpener	
4	Remove pencil from sharpener.		
5	Inspect pencil point.		
6			
7			
8			
9			
10			
	Equipment and Supplies Needed for This Set of Operations		
1	Pencil		
1	Pencil sharpener		

ASSIGNMENT 45, ACTIVITY 19
READING 21

Planning Processes

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading about planning processes:
   a. Identify ways in which a worker on a production line can help his company lower production costs.
   b. Discuss what happens when *new processes* are discovered *after* a product has already been designed.

Discussion

2. a. Given the term "product analysis," name the kinds of information obtained by a product analysis.
   b. Given the term "production flowchart," explain what it is.

Laboratory Activity

3. Given the operation sheets for all the processes required to manufacture salt and pepper shakers, *develop a production flowchart.*

Time Schedule

5 Overview
10 Presentation
10 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 Transparency 44, *Operation Sheet*
1 Transparency 45, *Planning Processes,* with overlays 1, 2, and 3

Equipment and Supplies for Laboratory Activity

Supplies

50 shts. 8½" x 11" paper
5 sets operation sheets from ACTIVITY 18D
1 set operation sheets from Teacher Demonstration (Assignment 44)

Overview (5)

1. For the last few days you have been planning the production of salt and pepper shakers. Today's reading described the planning that is required before product processing can begin.
2. I will talk about how a manufacturer chooses the *production processes* that will be used to make a product.
3. You will be asked to name some kinds of information found by analyzing a product, and to explain what a *production flowchart* is.
4. In the last laboratory activity you *analyzed a production process* in order to develop an *operation sheet.*
5. In today's laboratory activity you will use these operation sheets to help *develop a production flowchart* for the shakers.

Presentation (10)

1. A manufacturer must plan the production processes that he will use to make a new product. To do this, he analyzes the product.
2. Show Transparency 45, *Planning Processes.* Planning production processes is a major step between designing a product and starting to make it. The *basic processes* must be chosen, and the *operations* that make up each process must also be chosen.
3. Show Overlay number 1. The *drawings* and *specifications* for the product must be *analyzed* to determine what production processes will be required.
4. Show Overlay number 2. After they know what production steps are required, the production planners decide whether to *make* or *buy* the various parts that make up the product.
5. For any one process there may be *alternate ways* of doing work. Show Overlay number 3. After they study these alternate ways of doing work, the industrial engineers decide which way best suits

the company's resources. They must think of time, equipment, and costs.

6. Show Transparency 44, *Operation Sheet.* A production planner then arranges all the selected operations in the order in which they will be performed and prepares a *production flowchart.* Several kinds of symbols and abbreviations are used to show the processes.
7. This flowchart is studied. The time and cost requirements of each operation must be considered. The operations also must be checked against the design specifications.
8. This study may result in revising the production flowchart.

Discussion (10)

The following points can be raised concerning product analysis:

1. What is product analysis? (Studying how to make a product.)
2. What do you look for in product analysis? (What materials are required? What work on materials is required? How will the work be done?)
3. What is a production flowchart? (A graphic record or "picture" showing the *order of doing* the processes and the order of steps in each process.)
4. How is the production flowchart developed? (The product is *analyzed.* The *work* to be done is *identified.* A *plan* of work is drawn up.)

Laboratory Activity (20)

Today students will develop a production flowchart.

1. Students will work in their usual group of five.
2. Distribute paper to each student.
3. Move about the room, observing activities and answering questions.

Homework

Reading 28, *Designing and Engineering the Plant*

Note

Look ahead to Assignments 61 to 81 concerning Product and Processes R & D. Start gathering ideas for possible simple products that can be designed, engineered, and mass-produced within about 18 periods. Thought should be given to utilizing some of the specialized equipment you have in your laboratory. Thought should also be given to student interest in selecting possible products. The availability of materials should also be considered. *The teacher will need to limit the constraints for the product so that students do not get embroiled with too complex and difficult a product* for the time available.

Note

Look ahead to Assignment 51 and gather materials needed for the conveyor system.

ASSIGNMENT 46, ACTIVITY 20
READING 28

Designing and Engineering the Plant

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to designing and engineering the plant:
   a. Describe the kinds of transportation problems which must be solved by manufacturers of automobiles and dairy products.
   b. Explain why the availability of schools, homes, religious facilities, and recreation areas is important for a company to think about in choosing a good location.

Discussion

2. Given information related to efficient plant design and engineering:
   a. Name six factors to consider in choosing the location of a manufacturing plant.
   b. Name four goals in designing a plant layout.

Laboratory Activity

3. Given templates, information, and a routing schedule, *design* a manufacturing *floor plan* within a given plant area.

Time Schedule

5 Overview
10 Presentation - Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

10 pr. scissors (more, if available)

Supplies (Class)

50 rolls transparent tape
1 Chart No. 143, Manufacturing Corporation Plant Layout

Overview (5)

1. Today's lesson concerns designing and engineering a manufacturing plant.
2. The reading identifies some *ways of obtaining buildings* and some of the most common *reasons* for needing new buildings.
3. We will discuss some of the factors that management considers when choosing the location for a new building.
4. In the laboratory activity, you will *design a floor plan* for a production plant, to be used in manufacturing salt and pepper shakers.

Presentation - Discussion (10)

Discuss with students some of the most important factors involved in the design and engineering of a manufacturing plant. Develop Items 2, 3, and 7 on the chalkboard while calling on the students to volunteer the information.

1. Many factors must be considered in designing and engineering a manufacturing plant, and the tasks are very time-consuming.
2. What are several ways in which a manufacturing plant can obtain buildings?
   a. *Buying* or *leasing* some existing structure.
   b. *Constructing an addition* at the present site.
   c. *Constructing a new structure*, either for the entire production system or to handle additional production.
3. What *factors* does management keep in mind when it chooses a *location* for a manufacturing plant?
   a. Distance from *markets*.
   b. Distance from the *source of materials*.
   c. Availability and rates of *transportation systems*.
   d. Availability and cost of *labor*.
   e. Availability and cost of *utilities* such as electric power and gas.
   f. Kind of *climate*.
   g. *Water* supply.
   h. *Tax* rates.
   i. Availability and cost of *financing*.
   j. Distance from technical training *schools*, universities, and research facilities.
4. Who is in charge of designing buildings for production? (The company's plant engineer or an outside engineering firm.)

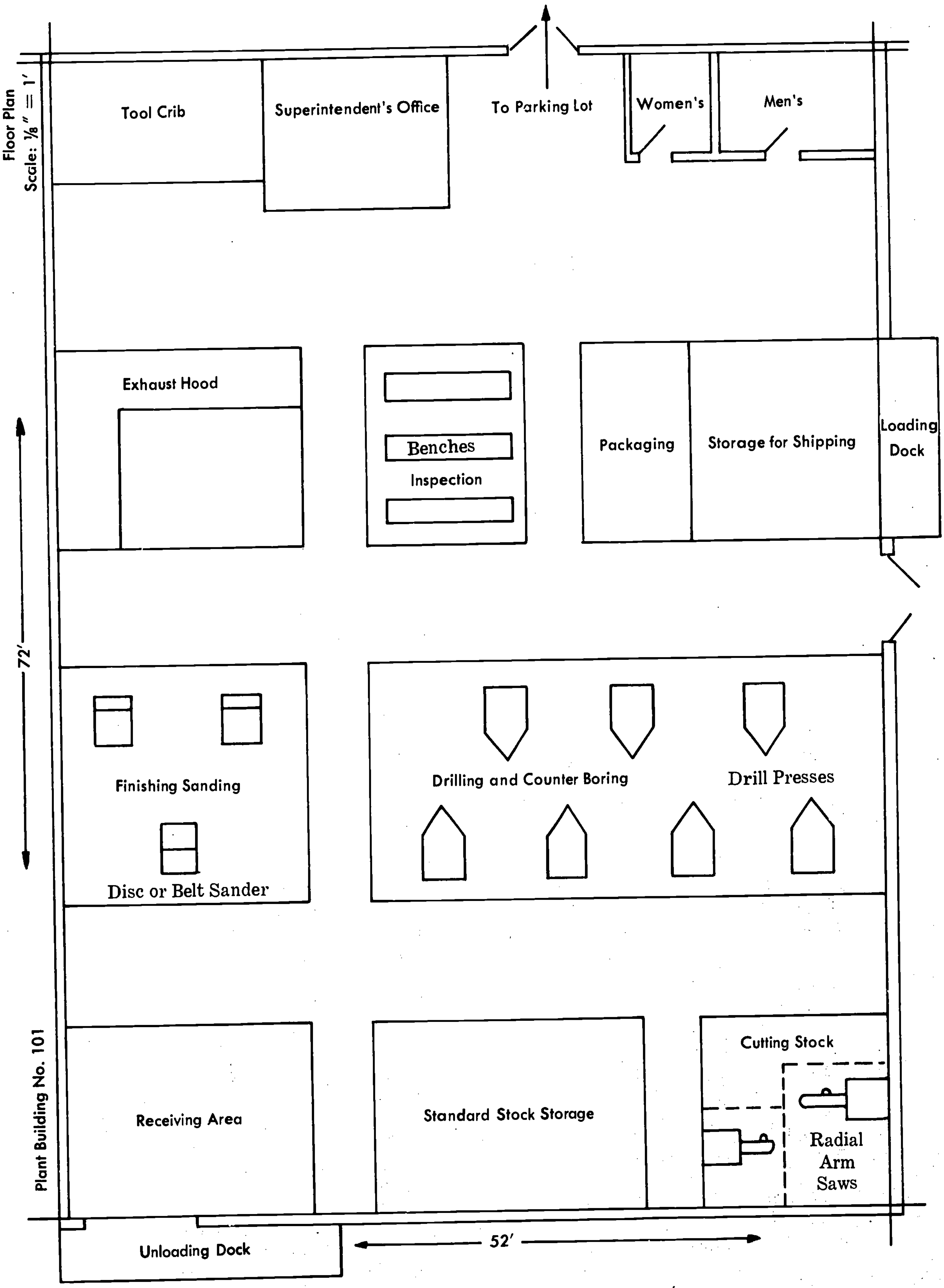


Fig. 46-1. Floor Plan

5. The plant designer starts by analyzing the products to be manufactured in the new plant. What does he need to find out?
   a. The *inputs*: what will go into the plant.
   b. The *processes*: what will be done to materials.
   c. The *outputs*: what products will come out.
   d. For all of these, answers to questions such as "How much?", "How fast?", "What special or unusual needs?".
6. Why are templates and models very helpful? (They can be moved around until the best possible floor plan is developed.)
7. What are the major goals in designing a plant layout?
   a. The least amount of *handling* for materials.
   b. Thrifty or economical use of *floor areas*.
   c. The least amount of *money* tied up in equipment.
   d. Using workers at their highest *skills* with the least wasted time.
   e. Providing *safe* and comfortable working *conditions*.

Laboratory Activity (30)

In the laboratory activity students will use templates to design a plant for manufacturing salt and pepper shakers.

1. Review with students the general conditions and design restrictions listed in Laboratory Manual Fig. 20-1, Design Restrictions.
2. Be sure that all students understand the suggested routing schedule, Laboratory Manual Fig. 20-2. You may want to revise this routing schedule to suit individual situations. Blank templates have been included on the template sheet, for use if additional or different steps are added to the routing schedule. You may want to display Chart No. 143 as a reference to show the location of a production area.
3. Have students follow the instructions in the Laboratory Manual.
4. A possible solution for the plant layout is Fig. 46-1, Floor Plan. *The teacher should specify (locate) where to place the loading dock.*

Homework

Reading 30, *Supplying Equipment and Materials*

Answers for Laboratory Manual

1. Answers will vary.
2. Yes.
3. Yes.
4. Yes.
5. Answers will vary.

Note

For Assignment 47, students will need five *different* equipment and supply catalogs.

ASSIGNMENT 47, ACTIVITY 21
READING 30

Supplying Equipment and Materials

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading related to supplying equipment and materials:
   a. List ways management can use to decide on whether to purchase *special* or *general* purpose equipment.
   b. Describe what could happen if a purchasing department did not *screen* its *vendors*.

Laboratory Activity

2. Given a list of items management has approved for purchasing, take part in bidding and purchasing activities between a purchasing department and several vendors.

Time Schedule

5 Overview
10 Presentation
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

5 different equipment-supply catalogs; Brodhead-Garrett, Sears, Paxton, Midwest, etc.
1 yardstick

Overview (5)

1. Yesterday you designed a plant layout for the manufacture of salt and pepper shakers.
2. Today you will be concerned with purchasing the needed equipment and materials for manufacturing salt and pepper shakers.
3. The reading explains *why* equipment and materials are needed, *what* equipment and materials are purchased, *why* they are purchased, *how* they are purchased, and *who* does the purchasing.
4. I will talk about the factors that affect the purchase of equipment and materials.
5. We will look at the routine *procedures* that are performed by the *purchasing department*.

Fig. 47-1. Factors to Considered in Buying Equipment and Materials

Technical Factors	Economic Factors
Equipment	
Capabilities (What can it do?) Cycle time (How long does it take?) Life (How long will it last?) Accuracy limits (How precise will it be?) Operator skill (Are special skills needed?) Safety (Is it safe?) Scrap rate (How much material will be spoiled?) Setup time (How long does it take to get ready?) Reliability and maintenance (Will it do the job? Can repairs be made easily?)	Cost of operation. Cost of owning, renting, or leasing. Total economic worth.
Materials	
Design requirements (Will the materials perform as required?) Safety (Are they safe?) Facilities required (What kind of storage is needed?) Workability (Can a change in form be made?) Waste (How much left over?)	Cost of raw materials, processed materials, or component parts. Cost of processing, fabricating, or assembling. Cost of inventory.

92

Presentation (10)

The *buying of equipment and materials* is handled by the *purchasing* department with management's approval.

1. Some factors that affect the purchase of equipment and materials are *technical.* Others are *economic* ones. (NOTE: The teacher may copy some items from Fig. 47-1, Factors to Consider, on the chalkboard and/or ask the students to name items that should be listed.)
2. Management decides whether to *make, buy,* or *lease* each kind of equipment. Management must also decide the *form of materials* to be purchased.
3. When management decides to buy something, it issues a *purchase requisition.* This *authorizes* the purchasing department to *start* purchasing.
4. The purchasing department usually follows a *standard procedure* for securing equipment and materials. (NOTE: The teacher may list these steps on the chalkboard.)
   a. *Choose* possible suppliers or vendors.
   b. *Ask* the vendors to *bid* or quote selling prices.
   c. *Analyze* the bids (quotations).
   d. *Issue* a purchase order — sometimes called "placing" the order.
   e. *Pay* for the goods, either when they are delivered or according to some other agreement.

Laboratory Activity (30)

Today's laboratory activity *simulates the practices* of industry in *purchasing* equipment and materials.

1. Divide the students into *six groups.*
2. Make the following assignments:
   Group 1: Purchasing Department for a manufacturer
   Group 2: Vendor A
   Group 3: Vendor B
   Group 4: Vendor C
   Group 5: Vendor D
   Group 6: Vendor E
3. Distribute a catalog to each vendor.
4. Review with students the general procedure for the activity:
   a. Management has decided that the items listed on the Bid Form, Fig. 21-1, are to be purchased. The Purchasing Department has called for bids.
   b. Each vendor group will use the prices that are listed in their catalog as a basis for their bid prices.
   c. The vendors are to include a small fee to cover shipping costs on the drill presses, radial arm saws, and combination belt-disc sanders.
   d. The vendors are to include a *quantity discount* of 10% on any item if more than two dozen of the item are wanted.
   e. While the vendors are determining the prices from the Bid Form, members of Group 1 are to copy the Bid Analysis Form, Fig. 21-2, from the Laboratory Manual on the chalkboard.
   f. As the completed Bid Forms are delivered to the Purchasing Department, results are to be recorded on the chalkboard.
   g. Group 1 can now determine the following:
      (1) The lowest price quoted on each item.
      (2) The vendor group that has been awarded the purchase orders for the most items.
      (3) The vendor group that will receive the most money from the purchase orders awarded to them.

Homework

If Optional Assignment 48 is used, review Readings 14 through 21, 28, and 30. If the optional assignment is omitted, there is no homework.

Answers for Laboratory Manual

1. Management
2. Yes
3. Yes
4. Yes
5. d

ASSIGNMENT 48 (OPTIONAL)

Review No. 2

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

Given the summaries of Readings 14-21, 28, and 30, ask and answer questions about obtaining approval of management, engineering the product, designing power elements, making working drawings, building prototypes, technical writing and illustrating, planning production, planning processes, designing and engineering the plant, and supplying equipment and materials.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to do one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking.
3. Have each group of students get together and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker, knowledgeable about product engineering and design or production planning to talk to the class. Schedule the speaker for the first class period and tape record his talk so it can be played to your other classes.
5. Schedule a field trip to a manufacturing plant to see activities related to the above readings.

Homework

None

ASSIGNMENT 49

Test No. 2

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 2, select responses from a list of items related to concepts presented in Readings 14 to 21, 28, and 30.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Distribute answer sheets and have students fill out needed information.
4. Pass out test booklets. Caution students to keep them closed until you say "begin."
5. Read directions for filling in answer blanks. Then direct students to open test booklet and begin.
6. Allow 35 minutes for completion, then collect answer sheets first; then test booklets, pencils, erasers, and eraser shields.
7. Review the test with students to provide feedback.

Homework

Reading 33, *Employment and Occupations in Manufacturing*

Note

Gather some employment ads from the local newspaper for use in Assignment 50. The ads should reflect managerial and production positions in both durable and nondurable product establishments.

Note

Check out your supplies needed for your conveyor system in Assignment 51.

Answers to Test No. 2

1. B	2. D	3. D	4. B	5. D	6. D	7. A	8. B	9. B
10. A	11. A	12. A	13. C	14. A	15. A	16. C	17. C	18. A
19. C	20. A	21. A	22. C	23. D	24. A	25. C	26. D	27. D
28. C	29. A	30. B	31. D	32. D	33. C	34. C	35. A	

ASSIGNMENT 50, ACTIVITY 22
READING 33

Employment and Occupations in Manufacturing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading about employment and occupations in manufacturing:
   a. Discuss how managers add value to products.
   b. Explain why service and government employees will increase the most from 1966 to 1975.
   c. Determine if manufacturing employees will increase or decrease.

Discussion

2. Given the terms "durable goods" and "nondurable goods," contrast the distinguishing *characteristics* of each *product group* and name *six* manufacturing areas in each class.
3. Given the presentation, name the occupation groupings of production workers and managerial groups.
4. Given the terms "data division," "people division," and "things division," differentiate among the three as used in job descriptions.

Laboratory Activity

5. Given several occupations, rate the importance of *data, people,* and *things* with a *three-digit code number.*

Time Schedule

5 Overview
15 Presentation
10 Discussion
15 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen
1 water-color pen

Supplies

5 to 10 employment ads from local newspapers
1 Transparency 50, *Categories of Manufacturing Employment*

Equipment and Supplies for Laboratory Activity

Equipment

1 filmstrip projector/screen

Supplies

1 Filmstrip 50, *Categories of Manufacturing Employment*

Overview (5)

Today's lesson concerns employment and occupations in manufacturing.

1. The textbook described how the labor force is divided into production jobs and management jobs in both the *durable goods* and *nondurable goods* employment

areas. It gave general information about the great number of occupations in manufacturing industries, and introduced a *way of coding occupations* to show how much the worker is involved with *data, people*, and *things*.

2. I will talk about employment in the fields of durable and nondurable goods. I will tell you more about *how to code occupations* in terms of *data, people*, and *things*.
3. During the discussion session we will talk about the *job classification* system of data, people and things, and review the main points of the three-digit code numbers.
4. You will have an opportunity to use this coding system to *classify different occupations in manufacturing industries.*

Presentation (15)

Today we will group jobs or occupations in manufacturing in several ways.

1. Manufactured products can be divided into two general categories: *durable goods* and *nondurable goods*.
   a. *Durable goods* are products that usually have a life of *three years or more.*
   b. *Nondurable goods* are products that usually last *less than three years.*
2. Show Transparency 50, *Categories of Manufacturing Employment.*
   a. Durable goods can be divided into ten areas. For example, TV sets and toasters fall in the "electrical equipment" area.
   b. There are also ten areas of nondurable goods manufacture. For example, a shirt manufacturer falls in the "apparel" area.
   c. One way to group jobs and occupations is to say that they fall in either a durable goods or a nondurable goods employment area.
3. Employment opportunities are expected to increase in some areas during the next few years, and to decrease in other areas.
   a. *Total employment* in the areas of lumber and wood, tobacco, petroleum and leather probably will *decrease.* (On the transparency enter a minus sign (—) beside these items.)
   b. All the other areas probably will increase; the *printing* and publishing area will be leading by 1975 with about 74% increase. (Enter a plus sign (+) beside Printing and Publishing.)
   c. (*Read* and show *employment ads* from newspapers. *Classify* the jobs according to each company's *products.*)
4. Another way to group occupations is to call them either *production* or *managerial employment.*
   a. *Production* employees *directly add value* to materials by changing the form of the materials. Production employees may be classified unskilled, semiskilled, or skilled. (Indicate which ads relate to production work.)
   b. *Managerial* employees *do not directly add value* to materials. They usually need more formal or academic education than the production workers. Managers, engineers, technicians, and clerical workers fall in the managerial group. (Indicate which ads relate to managerial work.)

There are many hundreds of different occupations. *Each occupation* requires the worker to perform certain *skills or tasks.* One way to *describe a job* is by showing how important *data, people,* and *things* are in *performing the job.*

5. *Working with data* might include searching for information, keeping records, reading and writing coded data, or solving problems that relate to data, and using symbols to do any of these things.
6. *Working with people* takes the form of exchanging ideas, teaching subject matter, persuading people, or attending to people's needs.
7. *Working with things* includes setting up or operating something that has shape and form, such as machines, tools, and equipment.
8. If you were ranking things according to how important they are, you probably would call the most important thing "Number 1," the next most important thing "Number 2" and so on.
9. The *code system* you will use today *works the same way,* except that "Number 0" is even more important or significant than "Number 1." Copy this information onto the chalkboard or refer your students to Fig. 22-2 in the Laboratory Manual.

Digit	Meaning
0	Highest possible importance
1	In rank order: less
2	than "Highest" but
3	more than "Average"
4	Average importance
5	In rank order: less
6	than "Average" but
7	more than "Least"
8	Least possible importance

10. The *code number* for an occupation has *three digits* to show the importance of working with data, with people, and with things. Copy Fig. 50-1 on the chalkboard.

Meaning of Place or Position

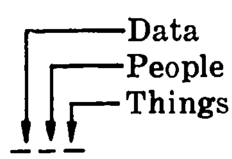


Fig. 50-1. Meaning of Place or Position

11. Here is an example. The job of a grinder setup man is coded with the number 380. Write the number on the chalkboard. This means that *his work with data is a little above average in importance, his work with people is not at all important, and his work with things is very important.* Code some of the employment ads for further examples.

Discussion (10)

Attempt to identify and clarify any unclear ideas about employment and occupation categories by asking these questions.

1. What are *durable* goods? (Those having a life of *three years or more.*)
2. What are *nondurable* goods? (Those having a life of *less than three years.*)
3. Name six durable goods manufacturing areas. (Military hardware, lumber and wood furniture, stone-clay-glass, primary metals, fabricated metals, electrical equipment, transportation equipment, instruments, machinery.)
4. Name six *nondurable goods* manufacturing areas. (Food, tobacco, textile mill, apparel, paper, printing and publishing, chemicals, petroleum, rubber, leather.)
5. How are production workers grouped, based on how complex or difficult their job tasks are? (*Unskilled, semiskilled,* or *skilled labor.*)
6. Name some occupations in the managerial group. (Managers, engineers, technicians, clerical workers, etc.)
7. In describing a job, what is considered under the "data" division? (Information, written records, symbols, ideas, etc.)
8. What is considered in the "people" division? (Exchanging ideas, teaching subject matter, persuading, attending the needs of people.)
9. What is included in the "things" division? (Operating or setting up machines, tools, and equipment.)
10. What is meant by a "data" value of 0? (That working with data is quite important to the job.)
11. What digit means "no importance" or "least possible importance? (The digit *8.*)

Laboratory Activity (15)

The use of Filmstrip 50 with the laboratory activity will provide the students a better opportunity to determine the importance of the "data, people, things" division for several occupations. *Use only as many frames as time adequately permits.*

1. Show one frame and give the job title.
2. Have students evaluate the importance of data, people, and things on this job, and *write a three-digit code number* in their Laboratory Manual.
3. Ask one student to give his code response. (Optional)
4. Tell the actual code given in the Teacher's Guide, so they can also write it in their Laboratory Manual.
5. Continue showing filmstrip frames.
6. After the activity has been completed, determine the most occupations that any student had correct. Allow ± 1 on each division for a correct response.

Homework

Reading 22, *Automating Processes*

Answers for Laboratory Manual

Title		Code
1.	Sewing machine operator	782
2.	Industrial truck operator	883
3.	Automobile painter, paint sprayer	781
4.	Aircraft assembler, structure and surfaces	381
5.	Engineering designer, aircraft structure	081
6.	Leather cutter	485
7.	Box maker, paperboard	884
8.	Engineering assistant, mechanical equipment	181
9.	Fur cutter	781
10.	Metallurgist	081
11.	Welder, (arc)	884
12.	Proof pressman	782
13.	Production foreman	138
14.	Shaper machine operator	782
15.	Plant superintendent	118
16.	Automobile assembler	887
17.	Electrical wire group assembler	884
18.	Engine assembly foreman	281
19.	Mechanical draftsman	281
20.	Metal fabrication foreman	130
21.	Proof technician, small arms	281
22.	Wood technologist	081
23.	Glass inspector	687
24.	Furniture assembler	884
25.	Cigar packer	687
26.	Cloth designer	081
27.	Men's and boys' clothing salesman, wholesale	358
28.	Tire inspector	384

Note

See Assignment 51 and gather the materials needed for the conveyor system. Determine how many conveyors will be needed between work stations.

ASSIGNMENT 51, ACTIVITY 23
READING 22

Automating Processes

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to automated processes:
   a. List some ways in which people can be helped when their jobs are replaced by automated equipment.
   b. Explain how automation has affected your life.

Discussion

2. Given the presentation, explain automation and identify three examples of automated processes.

Laboratory Activity

3. Given the materials and specifications, *assemble* and *place a conveyor belt* and unloading system appropriate for transporting salt and pepper shakers in production.

Time Schedule

5 Overview (see Item 4 in Overview)
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Problem 1: Groups 1, 2, 3, and 4

Equipment (To be shared)

2	drill presses *or*
1	drill press and
1	portable electric drill
2	5/16″ twist drills
1	stapler
2	claw hammers
3 pr.	slip-joint pliers
3	adjustable wrenches
1	1″ Forstner bit

Supplies (To be shared)

1 pc.	140′ plastic webbing cut to fit conveyors
1 btl.	rubber cement

Equipment (Each group)

2 6″ C clamps
1 spring clamp
1 pencil compass

Supplies (Each conveyor)

4 pcs. ¼″ x 6″ diameter plywood
2 4″ dia. qt. oil cans
2 pcs. 2″ x 4″ x 10½″ pine
4 pcs. 1″ dia. x 6″ dowel sticks
1 pc. friction tape, 20 ft. long
2 pcs. ¼″-20 x 12″ threaded steel rod
6 ¼″-20 hex nuts
10 steel lock washers, ¼″ I.D.
1 pc. ¾″ x 7½″ x 8′ to 12′ boards (conveyor bases)

See Figs. 23-1 to 23-5 in Laboratory Manual for assembly.

Problem 2: Group 5

Equipment (Group of 5)

4 straight tin snips
2 pr. scissors
1 crosscut saw
1 6″ try square
1 wooden mallet
1 medium-cut flat mill file
4 pcs. 2½″ x 6″ 24-gage sheet metal

Overview (5)

1. Today's reading explained that automating processes in a production system reduces or eliminates labor on certain jobs through *feedback, mechanical handling, program control,* and *data processing.*
2. I will explain automation and tell you some of the ways automated processes are used in industry today.
3. In the discussion you will be asked to explain automation and give some examples of how automation is used in manufacturing industries today.
4. In the laboratory activity you will fabricate and assemble a conveyor belt which is a *mechanical handling device. (First one or two classes only until the system is set up. The following classes should conduct a trial run as in ACTIVITY 24A.)*

Presentation (5)

1. *Automation* involves the design and development of mechanical devices to perform work formerly done by manual labor.
2. Automated processes depend on at least one of the following principles: *feedback, mechanical handling, programmed control,* or *data processing.*
3. In *feedback,* the output of a process or machine is measured and this measurement is used to regulate the machine. For example, a thermostat in a home heating system measures room temperature and regulates the heat output of the furnace.
4. *Mechanical handling* is the use of conveyors and other mechanical transfer devices to transport materials between production stations. An example is a conveyor belt in a soft-drink bottling plant. An escalator that moves people from one floor to another is a form of a conveyor system.
5. *Programmed control* means that a machine has been programmed or set to perform certain operations. An example is a hot-drink dispensing machine which you program to dispense black coffee, coffee with cream, coffee with cream and sugar, hot chocolate, etc. A kind of programmed control called *numerical control* is used on some machine tools. The instructions or directions are punched onto paper tape to control what the machine does. This is refined automation.
6. *Data processing* is a sequence of operations performed on data or information. Automated processes often make use of data processing. Computers process feedback information for some kinds of automated control.

Discussion (5)

The purpose of this discussion is to help the student understand some aspects of automation.

1. What factor is involved in the process of "automation"? (It always involves the use of mechanical devices to perform work which was formerly done by manual labor.)
2. What term is applied to the technique of using conveyor belts for automatic handling of materials? (Mechanical handling.)
3. Is use of a punched tape on a machine tool "data processing" or "numerical control"? (Numerical control.)

4. All "true" automation depends on what preparation for machine tool control? (Data processing on cards or tape to replace the thinking of a man.)

Laboratory Activity (30)

Today students will begin developing a materials-transportation system that simulates automatic mechanical handling. Make enough conveyors to go between the necessary work stations in your laboratory.

1. Divide the class into five groups (five students each). (First one or two classes only until the system is set up. *Other classes will proceed as in ACTIVITY 24A.*)
2. Assign four groups to manufacture or assemble and place conveyor belts like the one pictured in the Laboratory Manual. See Figs. 23-1 to 23-5.
3. Assign the fifth group to produce unloading devices for each conveyor and arrange the workbenches and equipment for installation of the conveyor system.
4. If the benches or machines in your laboratory are mounted to the floor, the conveyor belts are to be clamped onto 3/4" x 7½" boards, 8' to 12' long. They can be set up between work stations much more easily if made portable in this fashion.
5. Distribute supplies for each group. (NOTE: You should cut the belting to the lengths needed for spanning the distance between drums, after the drums are clamped in position on tables or board. Belt material may be stapled and taped together.)
6. Move from group to group, and assist or advise as needed.
7. Observe operations of machines to assure safe work practices.
8. Inspect the completed conveyor belts before students start the trial run.
9. Supervise the return of equipment and supplies.

Safety Precautions

1. Make sure all safety precautions are observed when operating power equipment; safety goggles or face shields are necessary.
2. The conveyor belt must be assembled to operate safely. All sharp edges on the sheet metal unloading device should be filed smooth.

Homework

Reading 25, *Tooling Up for Production*

Note

Look ahead to Assignment 52, Fig. 52-1, Inspection Tag. The teacher should duplicate inspection tags to be inserted in each approved product package, if desired.

Note

Look ahead to Assignments 61 to 81 concerning Product and Process R & D. Start gathering ideas for possible products that can be designed, engineered, and mass-produced within about 18 periods. Thought should be given to utilizing some of the specialized equipment you have in your laboratory. Thought should also be given to student interest in selecting possible products. The availability of materials should also be considered. *The teacher will need to limit the constraints for the product so that students do not get embroiled with too complex and difficult a product* for the time available.

ASSIGNMENT 52, ACTIVITY 24A
READING 25

Tooling Up for Production

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to tooling up for production:
   a. Describe what would happen if the *dimensions* of a produced part do *not* match the dimensions of that part shown on the engineering drawing.
   b. List the tooling-up changes which would have to be made by a television manufacturer who desires to change the size of the television viewing screen.

Laboratory Activity

2. Given a completed Process Flowchart:
   a. Check and adjust the production system setup for making salt and pepper shakers.
   b. Conduct a trial run.
   c. Complete a Job Description Sheet.

Time Schedule

5 Overview
15 Presentation
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Per class)

1	miter saw
2	conveyor systems
2	drill presses with fixtures
1	¾″ Forstner bit *or* spade bit
1	½″ Forstner bit *or* spade bit
1	electric hand drill w/jig
1	$\frac{1}{16}$″ twist drill
1	$\frac{3}{32}$″ twist drill
1	belt *or* pedestal stander w/80 grit paper
1	orbital sander w/120 grit paper
4	4″ C-clamps
3	4″ spring clamps

(This list may vary according to equipment available.)

Supplies (Per class)

1 pc.	1¼″ x 1¼″ x 7″ wood
2 cans	spray acrylic
2	#4 corks
1	dust cloth
2	cardboard boxes and newspapers (for spray finishing stations)
25	Production Flowcharts from ACTIVITY 19
25	inspection tags (See Fig. 52-1.)

Overview (5)

1. The textbook explains that engineers are responsible for tooling up. They make important decisions about the selection and placement of tools and equipment so that efficient production will be possible.
2. Today you will *set up the production system* for the salt and pepper shakers, and conduct a *trial run.*
3. First we will discuss how we can best arrange the equipment, so that we will have an efficient production system. (NOTE: This needs to be discussed even though the equipment may be set up.)
4. We will then check the equipment setup, adjust the conveyor system, and conduct a trial run to see if our production system will work efficiently.
5. You will be assigned a particular job in the production system.
6. At the end of the trial run, each student will fill out a Job Description Sheet as he completes his operations.

Presentation (15)

1. Tooling up for production includes several steps:
   a. Deciding what existing machines, tools, and equipment will be needed.
   b. Selecting all standard machine tools and equipment.
   c. Designing and ordering machines, tools, and equipment that must be specially made.
   d. Supervising the installation of machines and equipment, the start-up, and the trial run of production.
2. For your product, some of these tooling-up activities have already been accomplished in previous laboratory activities.
3. *Careful planning is important.* Without it, materials might not move efficiently from station to station.
4. Look at the *Process Flowchart* that was completed previously. It shows the sequence in which the machines will be used

in the production system. (Write the names of these machines, in sequence, on the chalkboard.)

5. Work benches also must be arranged, so that the conveyor system will move the materials efficiently from one work station to the next. (Take students into the production area. Show the positions of workbenches, the conveyor system, the machines, and work stations. Discuss the proper placement of equipment.)

Laboratory Activity (25)

1. Divide the class into three groups to perform these tasks:
   Check and adjust:
   a. Workbench locations.
   b. Conveyor systems.
   c. Machine locations. (NOTE: This step should probably be done each day for the next two days.)
2. When the production system has been checked and adjusted, assign students to their work stations according to the Process Flowchart.
3. Check to see that the proper equipment and supplies are ready at each work station.
4. Begin the trial run by starting a piece of wood through the system at the miter saw. Follow the process, step by step. Give instructions when necessary. Watch the students to be sure that they follow the safety precautions.
5. If the trial run shows any need for change, help students decide the needed changes. Changes must be noted in all Process Flowcharts.
6. Conduct another trial run. Then have each student fill out his Job Description Sheet when he completes his operation. See Fig. 52-1. Include an inspection tag in the packaging operation if desired.
7. Each student is to file this sheet and his flowchart.

Safety Precautions

1. Keep fingers away from cutting edges.
2. Wear safety glasses.
3. Do not disturb students who are operating machines.

Homework

None

Note

Look ahead to Assignment 55. Make a gage as illustrated in Figs. 25-4 and 25-5 in the Laboratory Manual.

INSPECTED BY #__________

Fig. 52-1. Inspection Tag

The teacher should duplicate an inspection tag or reasonable facsimile to be inserted in each product package. There should be one tag for each approved product.

ASSIGNMENT 53, 54
ACTIVITY 24B, C

Tooling Up for Production

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given a complete production system, manufacture one salt and pepper shaker set for each class member.

Time Schedule

Assignment 51
- 5 Overview
- 40 Laboratory Activity

Assignment 52
- 45 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

All production equipment, as listed in Assignment 52.
1 complete conveyor system

Supplies (Class)

All supplies, as listed in Assignment 52.
Enough wood stock to make a salt shaker for each student.
Enough wood stock to make a pepper shaker for each student.

Overview (5)

1. Today you are going to manufacture salt and pepper shakers. Each student will perform his assigned task in the production system.
2. Be sure to follow safety procedures when you are operating the machines.
3. If you do not produce enough shakers today, you will continue production in the next activity.

Laboratory Activity (40) and (45)

Salt and pepper shakers are to be manufactured today. If the class does not produce enough shakers today, they may continue production in the next activity.

1. Direct students to their assigned work stations. (Students may change jobs on the production line at your discretion.)
2. Try to discover the "bottlenecks" in the production system before they cause great difficulty. You may wish to change a student from one work station to another in order to speed up or slow down production in a certain area.
3. Be sure that students follow safety precautions.
4. See Fig. 53-1 for optional idea for making shakers.

Safety Precaution

1. Wear safety glasses if you are operating machines.
2. Keep fingers away from cutting edges.
3. Do not disturb students who are operating machines.

Homework

Reading 26, *Installing Production Control Systems*

Note

Look ahead to Assignments 61 to 81 concerning Product and Process R & D. Start gathering ideas for possible *simple products* that can be designed, engineered, and mass-produced within about 18 periods. Thought should be given to utilizing some of the specialized equipment you have in your laboratory. Thought should also be given to student interest in selecting possible products. The availability of materials should also be considered. *The teacher will need to limit the constraints for the product so that students do not get embroiled with too complex and difficult a product* for the time available.

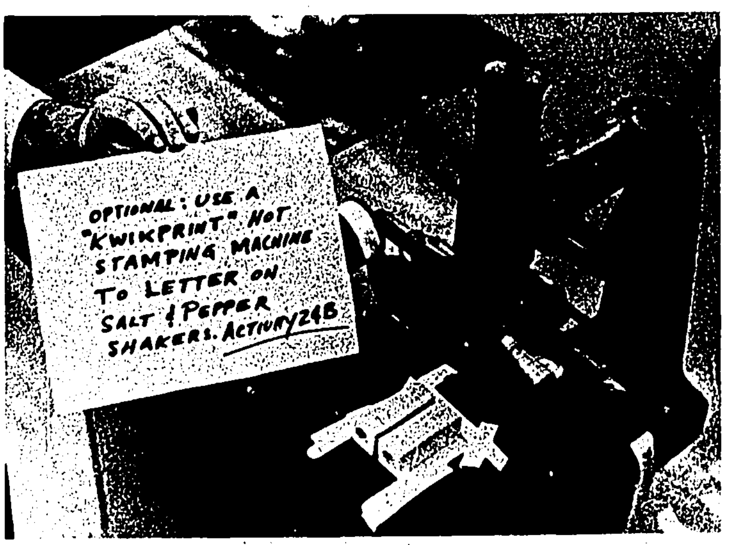


Fig. 53-1. Optional Idea for Marking Shakers

ASSIGNMENT 55, ACTIVITY 25
READING 26

Installing Production Control Systems

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading related to installing production control systems:
   a. List manufactured products which are processed by *mass production, custom production,* and *intermittent production.*
   b. List the kinds of materials you would find in the *inventory* of a bakery.

Discussion

2. Given the production control findings from Problem 1, identify and agree upon needed corrective action.

Laboratory Activity

3. Given a production system as described in the Laboratory Manual, *monitor, record, evaluate, and propose some form of corrective action.*
4. Given the experiences derived from Problem 1:
   a. Correct the production system.
   b. Continue to monitor, record, evaluate, and propose corrective action.

Time Schedule

5 Overview
5 Presentation
10 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 Transparency 55, *Phases of a Production Control System,* with three overlays.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 10: 2 groups per class)

1 inspection gage
1 pr. scissors
1 stapler
1 shoe box
1 hole punch (single)
1 1/8″ metal rod*

Supplies (Group of 10)

10 salt shakers
10 pepper shakers
20 #4 corks
10 3″ x 5″ product name tags (cut from Fig. 25-11)
25 Inventory Control Cards*

*For Optional Inventory Control System

Overview (5)

The installation of production control systems is related to the planning of the production system.

1. The reading described the need to *control production,* and the basic steps usually taken to control production: *monitoring, recording, reporting, evaluating, and correcting.*
2. I will explain the function of a production control system.
3. In the laboratory activity today, you will act as a part of a production system. You will serve in the role of a production unit and also as a part of the production control system.
4. Problem 1 of the laboratory activity will be followed by a discussion session. You will evaluate your observations and decide on changes to be made in the production system.
5. The production system will be corrected, and a second production run will be made.

Presentation (5)

Today I will explain and illustrate the main phases and functions of a production control system.

1. The main function of a production control system is to aid the *efficient flow* of workpieces through the plant, so that the *specified qualities* and quantities of products will be produced within a *preset time* and at a *preset cost.*

2. Show Transparency 55, *Phases of a Production Control System.* One phase of production control occurs during production planning. (Relate the plan shown to the students' production *planning* of salt and pepper shakers.)
3. Show Overlay 1. *Monitoring* is the checking and recording of actual work performance so that records can be maintained.
4. Show Overlay 2. *Evaluating* means continually comparing the monitored performance with the original plan.
5. Show Overlay 3. *Corrective Action* may mean changing some *planned* production technique or other detail when *evaluation* of *monitored* production shows that a change is needed.

Discussion (10)

This discussion period is scheduled to follow Problem 1. It will prepare students for Problem 2.

1. *Identify problem areas* in the production system by asking monitors to report on their observations.
2. Supplement the production control group's observations by asking the production group if they noted any production problems.
3. Ask the class to identify *alternative solutions* to eliminate the production "bottlenecks."
4. Have students discuss the possible alternative solutions and decide which solutions will be used to *correct* the production system. See Fig. 25-1 for possible solution.

Laboratory Activity (25)

Students are to play roles in a production system. They will *monitor* and *record* performance, *evaluate* performance by comparing it with the original plan, initiate corrective action, and run production again to *test* their corrections.

1. Set up the production system before class. See Fig. 25-1 in Laboratory Manual.
2. Divide the class into groups. The activity requires *groups of ten* students. Extra students can be used in monitoring and reporting.
3. Have groups assign students to work stations with *two or more monitoring and reporting.* One student should *check production time and record production volume per minute.* The other student should *monitor and record performance* at work stations. Others may look for hang-ups or *bottlenecks* in the production system.
4. Before starting Problem 2, students are to disassemble the packages and return to their seats for discussion.

Homework

Reading 31, *Processing Data or Information*

Note

1. See Fig. 55-1 for Optional Inventory Control System.
2. Leave the conveyor systems assembled, but store them until needed in Assignments 69-81.

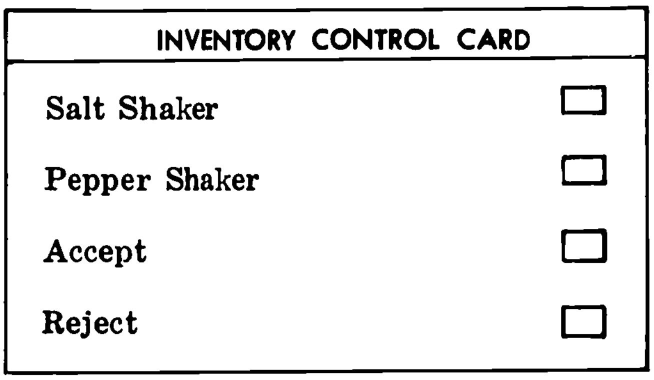


Fig. 55-1A. Preprinted, Prepunched Card

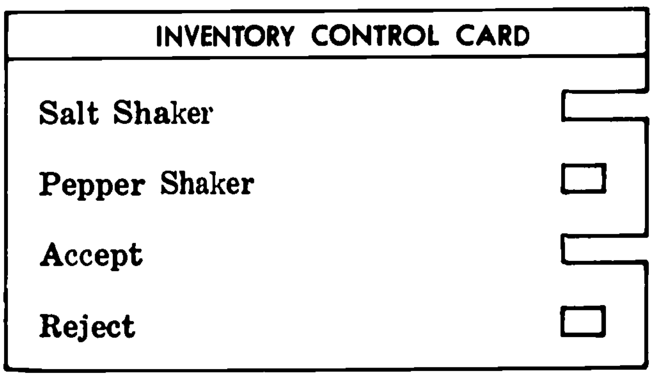


Fig. 55-1B. Card Slotted to Show Acceptable Salt Shaker

This is a suggestion for the teacher who wants to use an inventory control system.

This system would require a monitor who would be stationed beside the student using the inspection gage. The monitor would be provided with a supply of preprinted and prepunched inventory control cards. See Fig. 55-1A. One card is required for each unit produced.

The monitor's task is to watch the inspector and slot a card for each unit inspected. If the inspector is checking a salt shaker

and finds it's acceptable, the monitor will then cut a slot opposite "Salt Shaker" and another slot opposite "Accept." See Fig. 55-1B.

At the end of the period, if the teacher wants a count of acceptable salt shakers, he inserts a metal rod through the stack of cards at the "Salt Shaker" slot; all cards for salt shakers fall off.

He then collects the salt shaker cards, lines them up, and runs the rod through the "Accept" slot. All cards for acceptable salt shakers fall on the table, and a count is made.

ASSIGNMENT 56, ACTIVITY 26A
READING 31

Processing Data or Information

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to processing data or information:
   a. Explain why data cards should not be bent, folded, stapled, or otherwise mutilated.
   b. Explain what happens to the people who *originally* did the job that is now being done by data processing.

Laboratory Activity

2. Given the necessary equipment and supplies, record *numerical* and *alphabetic data* on a Port-A-Punch card.

Time Schedule

5 Overview
15 Presentation
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen
1 water-color pen

Supplies

1 set Transparencies:
56-1. *Port-A-Punch Card*
56-2. *Numerals*
56-3. *Letters*

Equipment and Supplies for Laboratory Activity

Equipment (Each student)

1 pencil (sharp)

Supplies (Each student)

2 Port-A-Punch cards, IBM DI0688

1. Yesterday you produced salt and pepper shakers, using production control systems. Without these systems the quality of the products would not have been very high.
2. The text described data processing, how data is recorded by punching cards, and the four fundamental functions that are involved in processing data.
3. I will show you *how* to record numerals and letters on a Port-A-Punch card.
4. In the laboratory activity you will have an opportunity to *record both numerical and alphabetic data* on Port-A-Punch cards.

Presentation (15)

I will explain why and how Port-A-Punch cards are used to process data.

1. We cannot talk directly into a computer

as if it were a telephone. The *information* we want to process *must be put in a form* that a calculator or computer can receive and process. *Punch cards* are used for this purpose. They permit man to communicate with a computer.

2. (Show Transparency 56-1, *Port-A-Punch Card*). A punch card has 80 columns. *Column 1* runs down the *left side* and *Column 80* runs down the *right side*. The Port-A-Punch card is *perforated* so that holes can be made easily by pressing with a pencil. Other cards are punched on a machine.
3. ONLY the *even-numbered* columns are *printed* on a Port-A-Punch card. Because the card has been perforated, the *odd-numbered* columns are needed for *reinforcement*, so they cannot be used.
4. There are *12 rows running across* a punch card. Beginning at the top of the card, these rows are numbered 12, 11, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The *zones are the top three rows*: 12, 11, and 0. The *numeric rows are numbered 1 through 9.*
5. (Show Transparency 56-2, *Numerals.*) A *numeral* or *digit* is recorded by a *single* punch in any column. On this card *zero* is recorded in Column 2, Row 0; *one* is recorded in Column 4, Row 1; *two* is in Column 6, Row 2; *three* is in Column 8, Row 3, etc. These numerals could be punched in any of the columns.
6. (Use a water-color pen to mark several numerals on the unused part of the card. Ask the students to identify them.)
7. (Show Transparency 56-3, *Letters.*) A letter is recorded by *two* punches in a column: a zone punch and a numeric punch. Letters *A through I* are recorded by one punch in *Zone 12* and one punch in a numeric row. Letters *J through R* are recorded by one punch in Zone 11 and one punch in a numeric row. Letters *S through Z* are recorded by a punch in *Zone 0* and a punch in a numeric row. Any letter may be in any column on the card.
8. (Use a water-color pen to mark several letters on the unused part of the card. Ask the students to identify them. Show students that an A may be in Column 2, 38, 80, or any other column.)
9. (Proceed to the laboratory activity if the presentation has been effective.)

Laboratory Activity (25)

This activity will give students an opportunity to record data on a punch card, so they may develop some understanding of the principles involved.

1. Supply students with two Port-A-Punch cards apiece.

   On *Card 1* each student will punch *numbers 0 through 9.*

   On *Card 2* he will punch letters *A through Z* of the alphabet.

   If desired, one card may be used for both.
2. Have the students check Cards 1 and 2 by laying them over the illustrations in their Laboratory Manual.

Homework

None

Note

Make arrangements with a local data processing establishment to provide you with a printout for IBM D10688 Port-A-Punch cards. Data cards will be produced in Assignment 57, ACTIVITY 26B.

ASSIGNMENT 57, ACTIVITY 26B

Processing Data or Information

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given a Port-A-Punch card and pencil, record their name and address.

Time Schedule

5 Overview
10 Presentation-Discussion
30 Laboratory Activity

Equipment and Supplies for Presentation - Discussion

Equipment

1 overhead projector/screen
1 transparency pen

Supplies

1 set Transparencies:
56-1. *Port-A-Punch Cards*
56-2. *Numerals*
56-3. *Letters*

Equipment and Supplies for Laboratory Activity

Equipment (Each student)

1 sharp pencil

Supplies (Each student)

1 Port-A-Punch card IBM D10688

Overview (5)

1. Yesterday's lesson concerned information and how it is processed.
2. You read about the four basic functions that are involved in data processing.
3. You recorded numbers and the alphabet on Port-A-Punch cards.
4. Today you will *record your name and address* on a Port-A-Punch card.

Presentation - Discussion (10)

Using the overhead projector and transparencies, review any or all of the previous assignment as needed. Give students ample opportunity to ask questions.

Laboratory Activity (30)

In this activity each student will record his name and address on a Port-A-Punch card.

1. Distribute the cards.
2. Each student is to record his *name, street address, city, and state.* Call attention to the limitations on length noted in the Laboratory Manual.
3. Have each student *write* his name on the back of his Port-A-Punch card. Collect the cards and package them according to class period.
4. The *teacher* should *prepare one card for each class* and stack it on top of each pile.
5. Upon request, these cards may be mailed to a printout center within your local area (for example, a telephone company or large industry) to be printed on sheets of paper called 80-80 Printout.
6. See Figs. 57-1 and 57-2 as alternatives to record as information.

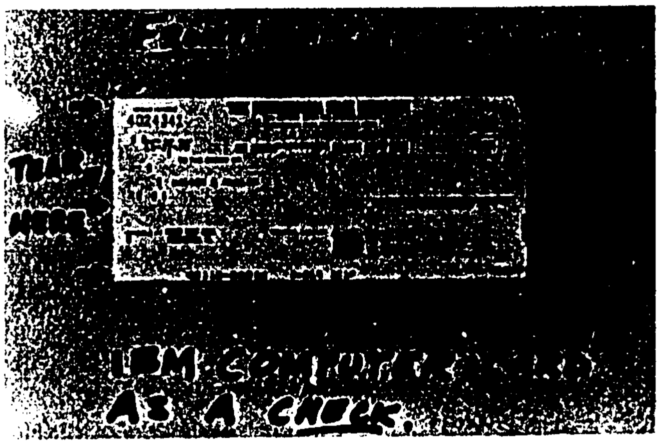


Fig. 57-1. Front of Computer Card Check

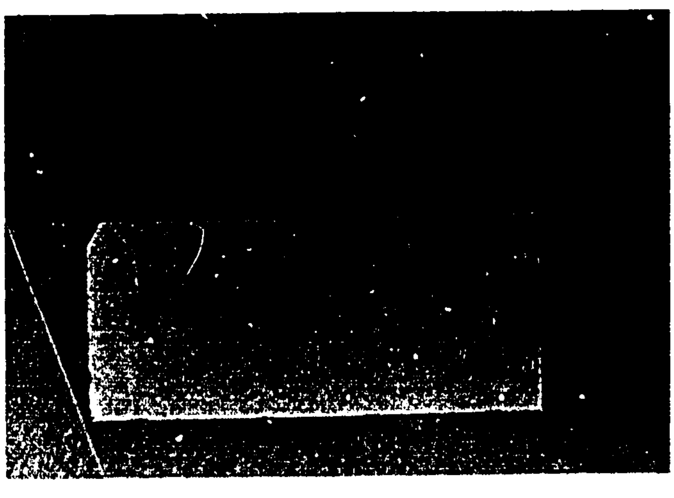


Fig. 57-2. Back of Computer Card Check

Homework

Reading 32, *Using the Computer*

Answers for Laboratory Manual

1. To put the data in a form that a calculator or computer can process.
2. Because there are 26 letters in the alphabet and only 9 numeric rows.
3. If every column were punched, the card probably would tear or rip. Skipping every second row leaves the card stronger.

Note

Take IBM Port-A-Punch cards to local data processing center to obtain a printout for student observation at a later date.

ASSIGNMENT 58, ACTIVITY 27
READING 32

Using the Computer

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about using a computer:
   a. List what a computer can do, and determine if a computer can do more than man directs it to do.
   b. List three things that a computer did for you and your family.

Discussion

2. Given two simple computer flowcharts, identify each one as being either a straight-line or a branching flowchart.
3. Given the four basic symbols, *rectangle, diamond, trapezoid,* and *circle,* identify their use on a flowchart.
4. Given the presentation, state how to solve a problem by a flowchart technique.

Laboratory Activity

5. Given a branching flowchart and some input data, *simulate* the operation of a *digital computer* to solve a problem in addition.

Time Schedule

5 Overview
10 Presentation
10 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 set Transparencies:
58-1. *Flowchart Symbols*
58-2. *Straight-Line Flowchart*
58-3. *Branching Flowchart*
58-4. *Warehouse Delivery Problem*

Equipment and Supplies for Laboratory Activity

Supplies (Each student)

1 sht. $8\frac{1}{2}'' \times 11''$ paper

Overview (5)

1. The lesson for today concerns the *computer and its use.* The text described the basic parts of an electronic computer and the major functions that each part performs.
2. Today I will describe the two basic types of computers and indicate examples of each.
3. We will discuss the *branching flowchart* which shows the way in which a digital computer arrives at an answer.
4. I will show you the *symbols* that are used most often in a flowchart and explain what they mean.
5. We will make a *simple flowchart,* using these *basic symbols.* In the laboratory, each of you will be given data and will *imitate the way* a digital computer *arrives* at an answer.

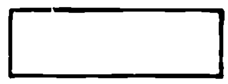
Presentation (10)

What is a computer? A computer is a machine that *processes* numeric information at an amazing rate of speed.

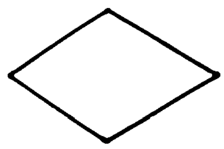
1. There are two types of computers commonly used today: *digital* computers and *analog* computers.
2. Digital computers solve problems by *counting,* just as a person does when he counts on his fingers. A cash register is a mechanical digital computer. It works by means of wheels that turn to various positions to represent various numbers. The register adds by counting the turns that the wheels make.
3. Analog computers *measure* one quantity *indirectly,* by measuring another quantity. A mercury thermometer works this way. It measures a thin column of liquid in a glass tube. The liquid expands and rises in the tube as the temperature rises. A bathroom scale indicates weight indirectly by means of a dial that moves, or a pointer that moves around a dial.
4. *Flowcharting* is the process of charting or *graphing the whole sequence of steps* that will be followed to solve a problem. Standard symbols are used to show the flow of data through a computer.
5. Here are some standard symbols used in making a flowchart. Show Transparency 58-1, *Flowchart Symbols.* These are the most common flowchart symbols:

Terminal — to *start* or *stop* a program.

Input/output—to *read* a card or *printout* on tape.



Processing—to show *what is being done* to data.



Decision—a point in the program where *decisions* are made.

Flow direction — *direction* of processing or data flow.

6. Show Transparency 58-2, *Straight-Line Flowchart.* This is called a "straight-line" flowchart. It will process all information the same way.
7. Show Transparency 58-3, *Branching Flowchart.* This is called a "branching" flowchart. It is a flowchart that branches in different directions according to the data that is being processed through it. Branching flowcharts will process input information differently, depending on the nature of the information and the directions given in the flowchart.

Discussion (10)

This discussion should review the use of a computer flowchart. Also, students will follow a branching flowchart as a digital computer would operate.

1. What is the purpose of a flowchart? (To record the procedure for solving a problem. To show the sequence of steps.)
2. Can you describe or draw the computer symbols for the following ideas?

110

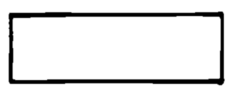
a. Start or stop a program.

Terminal 

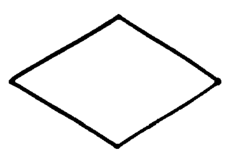
b. Read a card or printout on tape.

Input/output 

c. Show an addition or subtraction process.

Processing 

d. Compare one number to another.

Decision 

e. Flow of data or direction of processing.

Flow direction 

3. Let's see if we can design a simple flowchart.
   a. This is the data needed for input. (Show Transparency 58-4, *Warehouse Delivery Problem.*) How many delivery trucks are needed on Saturday to deliver one week's sale of lawnmowers?

No. of Mowers Sold		Day of the Week
5	A	Monday
3	B	Tuesday
2	C	Wednesday
8	D	Thursday
4	E	Friday

   b. These are the directions for solving an arithmetic problem in statement form. Show overlay to Transparency 58-4, *Written Solution.*
      (1) *Start* the procedure.
      (2) *Read* in five numbers.
      (3) *Add* the numbers.
      (4) *Read* in number 25.
      (5) *Compare* the sum with the number 25.
      (6) *If* the sum is greater than 25, go to Step 10. If the sum is equal to or less than 25, go to Step 7.
      (7) *Print* the answer on output sheet.
      (8) *Punch* card for one delivery truck.
      (9) *Go* to Step 12.
      (10) *Print* the answer on output sheet.
      (11) *Punch* card for two delivery trucks.
      (12) *Stop.*
4. Continue to show the overlay to Transparency 58-4 while you design the flowchart on the chalkboard. Ask for student suggestions at each step. See Teacher's Guide Fig. 58-1.
5. This was a branching flowchart which shows the way in which a digital computer arrives at an answer.
6. Let's follow another branching flowchart, as a digital computer would operate. Show Transparency 58-3, Overlay 1. Let's put this row of input data through the flowchart.
7. Our "start" position is with the right-hand character of the input data.
8. Follow through the flowchart and mark your changes in the Data Processing Answer Chart. See Fig. 27-3 in the Laboratory Manual. (NOTE: You are only following the flowchart—*do not* indicate to the students that you are doing an addition problem.)
9. Remove the overlay and quiz the students to check their ability to *comprehend the branching* of the flowchart.

Laboratory Activity (20)

Today each student will simulate the operation of a digital computer by following a branching flowchart.

1. Assign *each student a row number* (1 through 25) from Laboratory Manual Fig. 27-2, Input Data Chart.

2. Have the students begin at the *start* position of the flowchart and follow the directions. They are to *record* all of their work in the Answer Chart, Fig. 27-3.
3. Interesting things should happen. Many students will not follow the instructions carefully and will make errors. Some will not recognize what they have done after they have completed their work. This will have to be explained to them again.
4. A sample of how the flowchart has been followed is shown in Fig. 58-2. Row 16 of the input data was used.

Notice that the flowchart was followed. It directed the user to decrease the two digits (3 and 6) located directly left of the letter B, to zero.

5. If all the data is *properly processed* in the flowchart, the *last digit* in the *two columns to the left of A will be 4 and 9.* The *last digit* in the *two columns to the left of B will be 0 and 0.*

Homework

Review of Readings 22, 25, 26, 31, 32, and 33 if optional Assignment 59 is used. If As-

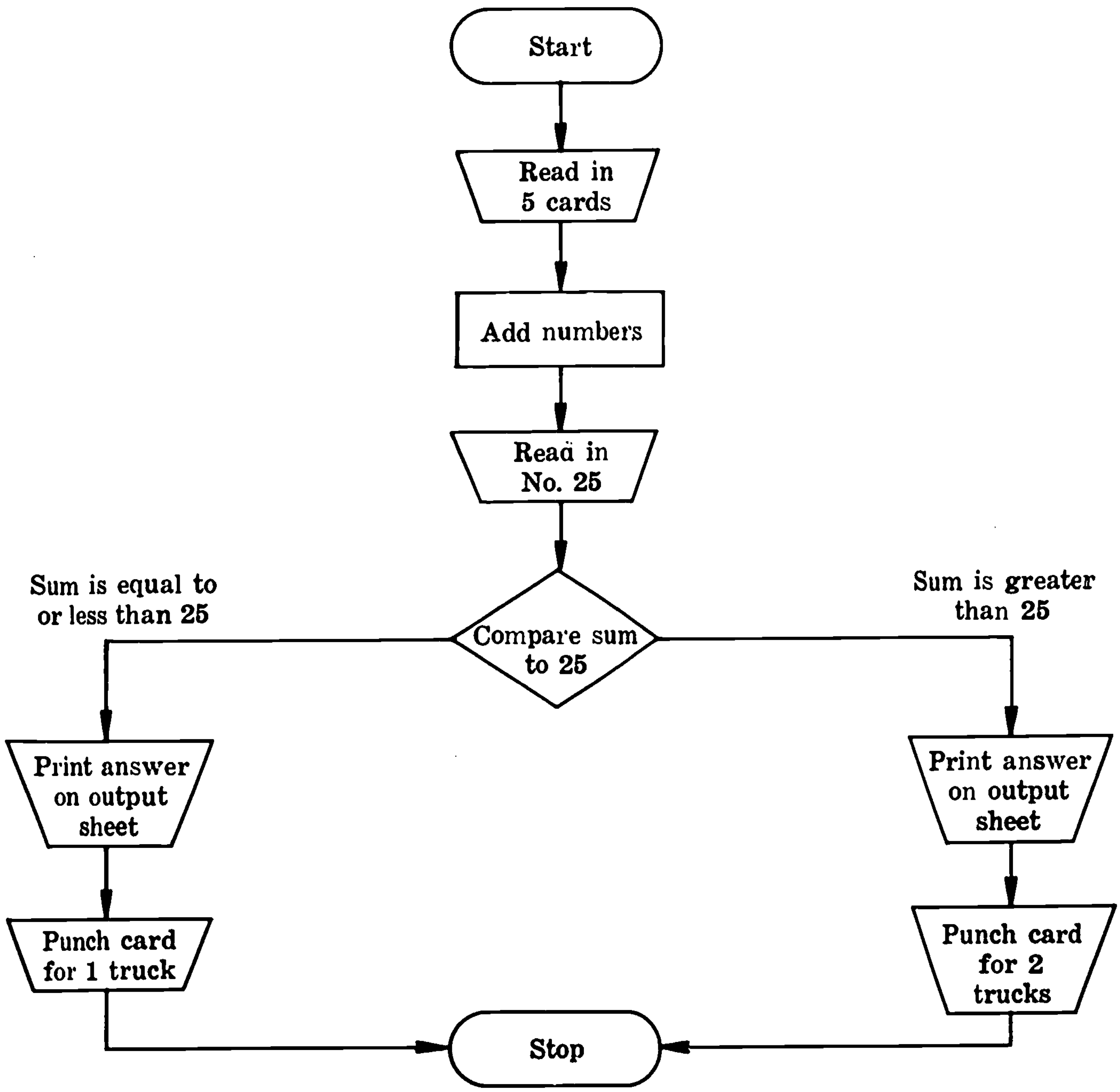


Fig. 58-1. Warehouse Delivery Problem

	Input Data (Copy a row of symbols from Fig. 27-2).										
Row No. 16	0	1	3	A	3	6	B	0	0	0	0
		2	4		2	5					
Effects of Flowchart Instructions		3	5		1	4					
		4	6		0	3					
			7			2					
			8			1					
			9			0					

← Start here.

Fig. 58-2. Data Processing Answer Chart

signment 59 is not used, there is no homework.

Answers for Laboratory Manual

1. Addition
2. Digits
3. Characters
4. Digital
5. Punched card
6. Branching

Note

Look ahead to Assignments 61 to 81 concerning Product and Process R & D.

ASSIGNMENT 59 (OPTIONAL)

Review No. 3

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

Given the summaries of Readings 22, 25, 26, 31, 32, 33, ask and answer questions about: employment and occupations in manufacturing, automated processes, tooling up for production, installing production control systems, processing data, and using a computer.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to choose one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking and discussion.
3. Have each group of students get together and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker who is knowledgeable about automated processes or data processing to talk to the class. Schedule the speaker for the first class period and tape-record his talk so it can be played to your other classes.
5. Schedule a field trip to a plant where the following activities can be observed:
   a. Automated processes
   b. Tooling up for production
   c. Processing data
   d. Computer operation

Homework

None

ASSIGNMENT 60

Test No. 3

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 3, select responses from a list of items related to concepts presented in Readings 22, 25, 26, 31, 32, and 33.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Distribute answer sheets and have students fill out the needed information.
4. Pass out test booklets. Instruct students to keep them closed until you say, "Begin."
5. Read directions for filling in answers. Have students open test booklets and begin.
6. Allow 35 minutes for completion. Collect answer sheets first, then test booklets, pencils, erasers, and eraser shields.
7. Review the test with students to provide feedback.

Homework

Reading 5, *Manufacturing Management Technology*

Answers to Test No. 3

1. A	2. C	3. B	4. C	5. D	6. A	7. D	8. D	9. A
10. C	11. C	12. A	13. C	14. D	15. C	16. B	17. A	18. D
19. C	20. A	21. A	22. A	23. C	24. D	25. A	26. D	27. A
28. A	29. C	30. D	31. B	32. C	33. C	34. B	35. B	

114

ASSIGNMENT 61, ACTIVITY 28
READING 5

Manufacturing Management Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to manufacturing management technology:
   a. Give examples of long-range and short-range planning that your family does.
   b. Describe how a homework assignment is *controlled* by a teacher and by a student.

Discussion

2. a. Given any manufactured product, name the three technologies required to manufacture that product.
   b. Given the concept Manufacturing Management Technology, name three broad areas of knowledge within this concept.

Laboratory Activity

3. Given a product to be manufactured, state several planning, organizing, and controlling functions of management which would be necessary for manufacturing the product.

Time Schedule

5 Overview
15 Discussion
25 Laboratory Activity

Equipment and Supplies for Discussion

Equipment

1 manufactured product, selected by teacher, to be used during discussion

Equipment and Supplies for Laboratory Activity

Supplies (Per class)

1 red pencil

Overview (5)

1. So far in the course you have learned about researching, designing, and engineering a *product*. You have also learned about researching, designing, and engineering a *process*. In the next few weeks you will be researching, designing, and engineering *both a product and process.*
2. Today we will talk about manufacturing *management* technology.
3. I will explain the functions of *planning, organizing, and controlling* the manufacture of a product.
4. You will be asked to name the three basic technologies required for the manufacture of products.
5. During the laboratory activity groups of students, acting as managers, will decide on the necessary functions for planning, organizing, and controlling the manufacture of a product.
6. When the activity is completed, the *most efficient group of managers* (those who do the best job of planning, organizing, and controlling) will be asked to *report their management system* to the class.

Discussion (15)

It is suggested that the teacher choose a simple product (one that he has been considering for the past few weeks for this activity) with whose manufacture he is familiar, and develop the discussion using that product as an example. See Figs. 61-1 to 61-14.

1. Have students open their Laboratory Manuals to Figs. 28-1, 28-2, and 28-3.
2. Ask students what three basic technologies are required to manufacture any product and the selected product. (Management, production, and personnel technology.)
3. Ask students for the three *broad* areas within manufacturing management technology which lead to the efficient production of any product. (Planning, organizing, and controlling.)
4. On the chalkboard write this definition of planning:
   a. Deciding *what* to manufacture.
   b. Deciding the *best way* to manufacture the product.

SUGGESTED PRODUCTS

Games and Toys
Tic-tac-toe, checker board, railroad train (simple), ring toss, simple puzzles, electronic fire siren or alarm system

Decorations
Christmas tree ornament, table decoration, wall plaque, psychedelic light

Boxes
Shoe shine box, silverware box, rocket or LSRAV carrier, hobby box, jewelry box, small parts box

Accessories (kitchen)
Napkin holder, cheese tiles or boards, ice tongs, bulletin board, key holder, cutting board, salad utensils, trivet, corn skewers, mug, coasters

Accessories (sports)
Fishing lures, sinkers and bobbers, boxer's jump rope, boomerang

Accessories (men, boys)
Trouser hanger, tie rack, tie clasp, change purse, shoe rack

Accessories (desk)
Name plate, pen and pencil holder, memo pad, book holder, letter opener, embedded objects in plastic

Accessories (women, girls)
Pin cushion and thread holder, jewelry (pins, bracelets, rings), knitting needles, weaving frames

Miscellaneous
Wall shelves, record holder, candle holder, candy dish, picture frame

POSSIBLE MATERIALS

1. Wood, particleboard, other compositions
2. Sheetmetal, wire, band, rod
3. Foundry metals
4. Plastics (sheet, rod, tube, foam, liquid)
5. Cork
6. Clay
7. Glass (sheet, rod, tube)
8. Cardboard or paper
9. Fabrics (burlap, felt, vinyls, cloth, rope)
10. Leather

Fig. 61-1. Product and Process R & D
Products must have no more than five components (fabricated by class).

Have students copy this definition in Fig. 28-1.

5. Using the example product you choose, mention some of the factors involved in planning to make the product. Include factors that involve formulation, researching, designing, and engineering. Refer to Figs. 28-1, 2, and 3 for appropriate questions concerning these areas.
6. After management has approved a product for manufacture, the product is designed and engineered. Then *organizing* for the manufacture of the product is the next step.
7. On the chalkboard write this definition of organizing: *Getting ready to do.* Have the students copy this definition in Fig. 28-2.
8. Mention some of the factors involved in organizing for production of the product you have selected which involve structuring and supplying. Again refer to Figs. 28-1, 2, and 3 in the Laboratory Manual for appropriate questions.
9. Once production is organized, management must take steps to *control* the process.
10. On the chalkboard, write this definition of controlling: *Checking to see if the job is getting done.*

    Have students copy this definition in Fig. 28-3. Note some of the questions asked under *directing, monitoring, reporting,* and *correcting* which relate to the product you have selected.

Laboratory Activity (25)

1. Suggestions have been made in the Laboratory Manual regarding a product on which to base the activity. Students may wish to add to this list. NOTE: If students have no preference, the teacher should suggest a simple product; it is the basis of future activities. See Fig. 61-1.
2. Have the class choose one of the products by popular vote.
3. Students are to work in groups of five. Assign a number to each group for identification purpose.
4. In order to avoid a delay at the end of the activity, begin checking the first completed sheets, Fig. 28-1, promptly.
5. Beside each function which is correctly listed, enter a + 1 using red pencil. If the management function is not entered under the correct heading, score it as a

— 1. Only one Laboratory Manual in each group needs to be checked, although all students should complete Figs. 28-1, 28-2, and 28-3.

6. Approximately 10 minutes before the end of period, groups should stop work and tabulate the total number of points they earned. Be sure they total the positive points and the negative points separately, then subtract negative points to arrive at a score.
7. Have each group *foreman* check another group's tabulation.
8. Ask each *group to report its score*. Record all scores on the chalkboard using the group numbers for identification.
9. Identify the winning group as "the most efficient managers." Have them report their management system to the entire class if time permits.

Homework

Reading 6, *Inputs to Manufacturing*

Note

Start students thinking about a *simple* product to produce. You might give them a list of two or three possible products that can be made with materials available and equipment available. Figure 61-1 is a list of possible products.

Note

Preview Filmstrip 62. The commentary for the filmstrip is included in Assignment 62.

Example Mass Production Product

Psychedelic Light

Equipment

1 5/8" spade bit
1 X-acto® knife
1 pr. scissors
1 stapler *or* cellophane tape
1 main pattern template

Supplies (Per lamp)

3 candelabra screw sockets
3 flasher light bulbs
1 24" lamp wire
1 plug
1 sht. .010" *or* .020" x 6¼" x 10" translucent styrene plastic sheeting or equiv.
1 sht. .028" x 20" x 22" chipboard or equiv.
1 tube polyvinyl glue
1 sht. 20" x 22" contact vinyl or contact paper, psychedelic pattern
1 sht. 5" x 11" construction paper
1 pc. ¾" x 1½" x 8¾" wood
1 pc. ¼" x ¾" x 10" wood strip

Procedures (Study Figs. 61-2 through 8)

Making the Housing

1. Using the main pattern template, trace the layout onto the chipboard. See Fig. 61-2.
2. Using the main pattern, trace ½" outside the template or contact paper layout.
3. Cut out chipboard housing.
4. Glue a 1" x 5½" piece of chipboard to the backside of each vertical side of the screen for reinforcement.
5. Glue a ¼" x ¾" x 10" strip of wood to the back of the top of the screen as reinforcement. See Fig. 61-7.
6. Score all fold lines.
7. Staple or tape the .020" x 6¼" x 10" translucent styrene to front of screen. See Fig. 61-6.
8. Glue front flanges to back of screen.

Covering

9. Cover front and edges of screen frame by folding half of a 1½" strip of contact

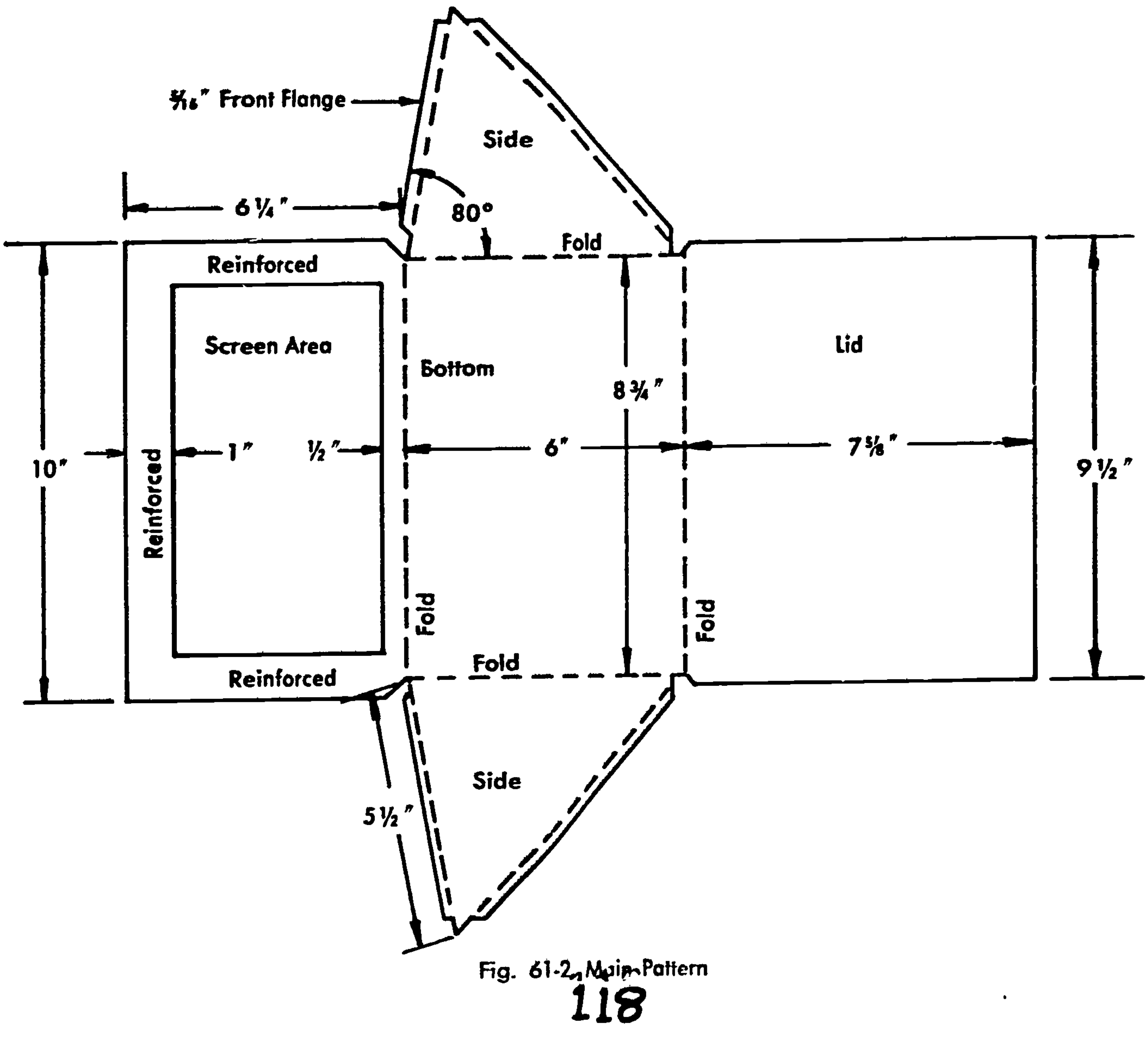


Fig. 61-2. Main Pattern

118

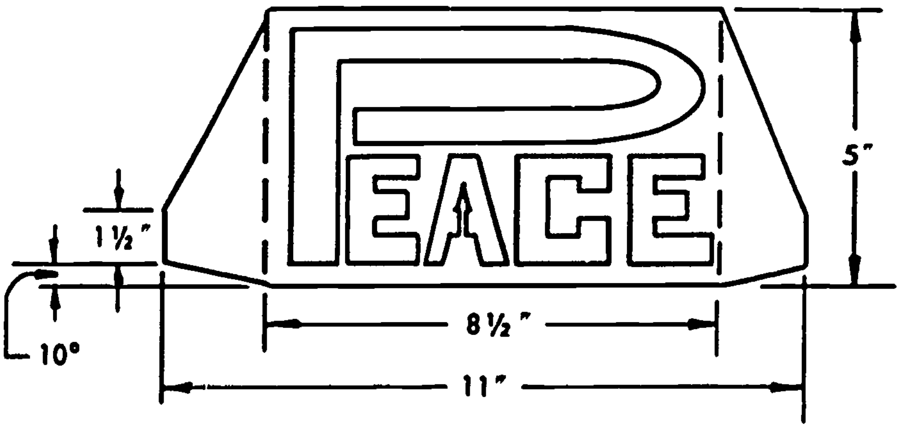


Fig. 61-3. Cut Out

paper over the front of the screen and half over the back of the frame.

10. Cut out contact paper pattern. Cover the rest of the outside surface with psychedelic design contact paper. See Fig. 61-8.

Making Electrical Unit

11. Drill three ⅝" holes for light sockets in a ¾" x 1½" x 8¾" piece of wood. See Figs. 61-3 and 61-4.
12. Assemble candelabra sockets, wire, flashing bulb in the wood base and fasten the plug to the wire. Wire the flashing bulbs in parallel. Test lights. Bulbs need to heat awhile before flashing starts. See Fig. 61-7.

Assembling and Operating

13. Glue the wood base inside the housing, on the bottom, 1¾" forward of the lid fold line. If lid tends to bend, it can be reinforced with two strips of wood. See Fig. 61-7.
14. Draw and cut out stencil design on 5" x 12" construction paper. Fold ends and insert behind the screen. See Figs. 61-5 and 61-7. Plug in and smile.

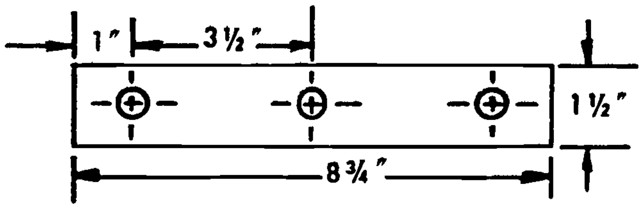


Fig. 61-4. Light Base Bar

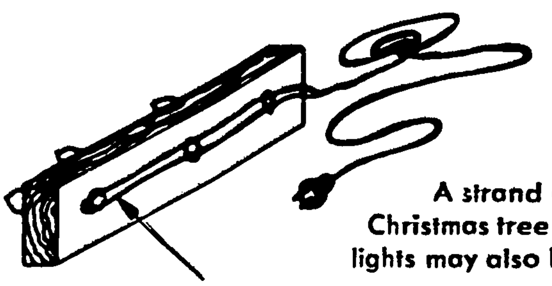


Fig. 61-5. Circuit Assembly

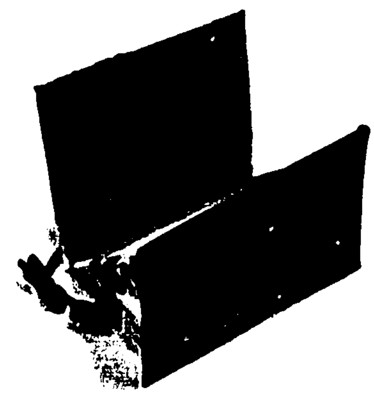


Fig. 61-6. Psychedelic Light
Front view showing screen and open lid.

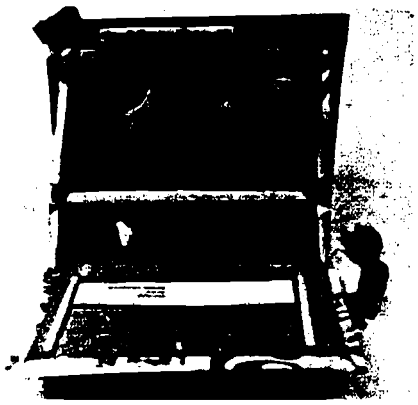


Fig. 61-7. Psychedelic Light
Rear view showing screen cut out, light base bar, lid, and reinforcement.

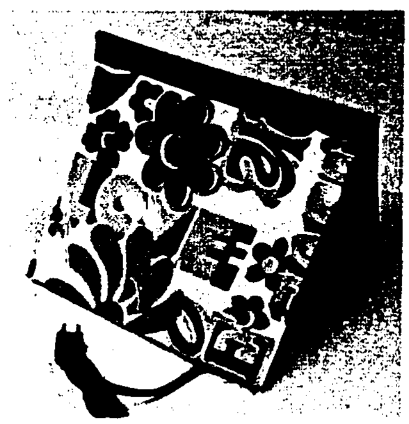


Fig. 61-8. Psychedelic Light
Rear view showing contact paper decoration.

Example Mass Production Product

Electronic Fire Siren Game or Alarm System

Equipment

1 screwdriver
1 pr. pliers (needlenose)
1 pocket knife *or* abrasive paper
1 5/64" twist drill
1 7/16" twist drill *or* 1/4" twist drill (for speaker sound holes)
1 btl. rubber cement
1 soldering gun and solder

Supplies (Per product)

1 PNP power transistor (Calectro K4-521 *or* Olson TR-15)
1 NPN transistor (Calectro K4-506)
1 capacitor .022 mfd. (microfarad) at 16V
1 100K ohm resistor for main circuit (brown, black, yellow)
1 470K ohm resistor for high siren tone (yellow, violet, yellow)
1 8 ohm 3" speaker (Olson Electronics)
1 9-volt transistor battery
5 pcs. #22 enamel coated wire 5" long
1 roll scotch *or* masking tape
3 fahnestock clips
1 pc. 3 3/4" dia. cardboard disc
1 pc. 3 11/16" dia. cardboard disc
5 1/8" x 1/2" bolts and nuts
2 pcs. 1/4" x 1" copper *or* brass strip (switches)
4 washers 1/8" I. D.
1 8 oz. plastic margarine cup with plastic snap-on lid (See Fig. 61-13.)

Procedures (Study Figs. 61-9 through 14)

Preparation

1. Reproduce and cut out circuit board. See Fig. 61-9. Glue circuit board to the 3 11/16" cardboard dics.
2. Clean about 1/2" of enamel from the ends of each wire.
3. Cover the bottom of the power transistor with scotch tape or masking tape for insulation.
4. Drill five 7/16" speaker holes and four 5/64" holes for switch terminal bolts. Drill 5/64" holes in one end of each 1/4" x 1" brass or copper switch.

Assembling Circuits

5. Make a subassembly by twisting the wire lead (B) from the audio resistor base (NPN) with a lead from the 100K resistor and a lead from the 470K resistor. Then twist a lead from the .022 mfd. capacitor to the same common twist joint. Clamp the ends with a fahnestock clip.

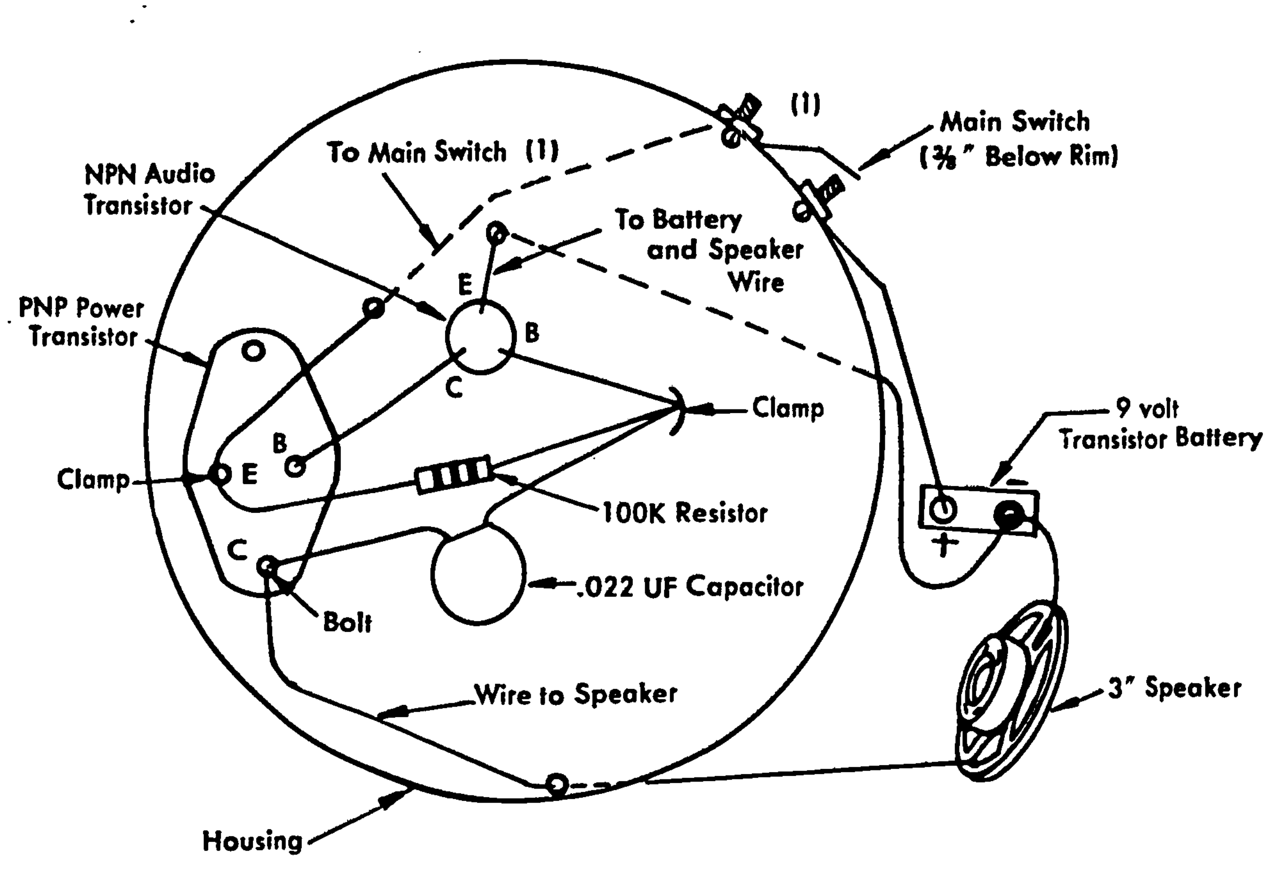


Fig. 61-9. Circuit Board Front View

6. Attach the collector lead (C) of the audio transistor (NPN) to the base of the PNP power transistor (B) using a fahnestock clip.
7. Solder a 5" wire to each of the two terminals on the loudspeaker.
8. Attach another 5" wire to the positive (+) terminal of the battery.
9. Cut a ¾" hole in the middle of the 3⅜" cardboard disc for a speaker retainer ring.
10. Attach the loose lead of the .022 mfd. capacitor to the collector (C) of the PNP transistor with the ⅛" x ½" bolt and nut. Attach one speaker wire to the same bolt.
11. Attach the other speaker wire to the emitter (E) of the NPN transistor and to the negative (—) terminal of the battery.
12. Connect a wire to the emitter (E) of the PNP transistor and to the main switch.
13. Connect a wire from the positive (+) terminal of the battery to the other bolt at the main switch. The wire should be between the bolt head and the washer. Install the switch.
14. Connect the other lead of the 470K resistor to the high-tone switch at one bolt.
15. Connect a wire from the other bolt at the switch to the PNP emitter. Install the high-tone switch.
16. Separate wires where shorts may occur. Inspect for tight connections. Snap cap on container. Test for sound.

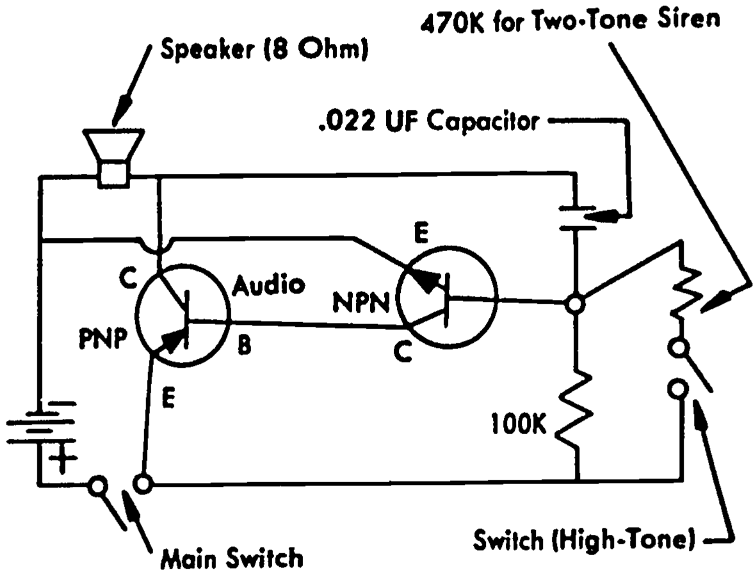
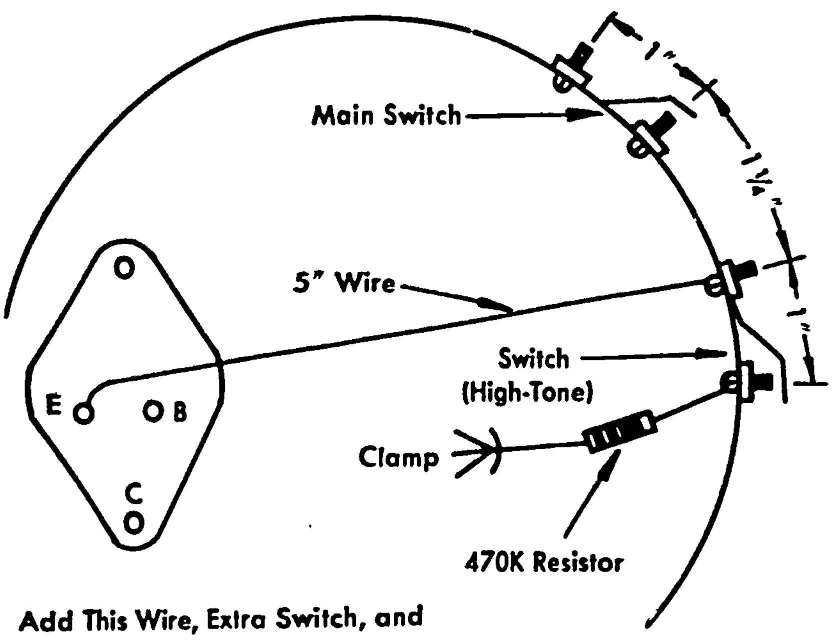
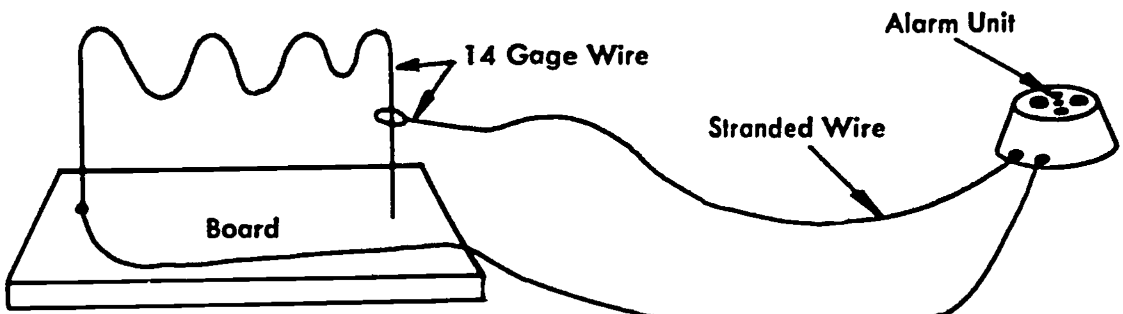


Fig. 61-10. Schematic Drawing



Add This Wire, Extra Switch, and 470K Resistor to the Circuit to Get the High-Tone Response

Fig. 61-11. Extra Switch Assembly



Make a Nerve-Tester Game by Connecting a Loop Follower to a Terminal of the Main Switch and a Wire Obstacle Course to the Other Terminal of the Main Switch

Fig. 61-12. Nerve Tester Game

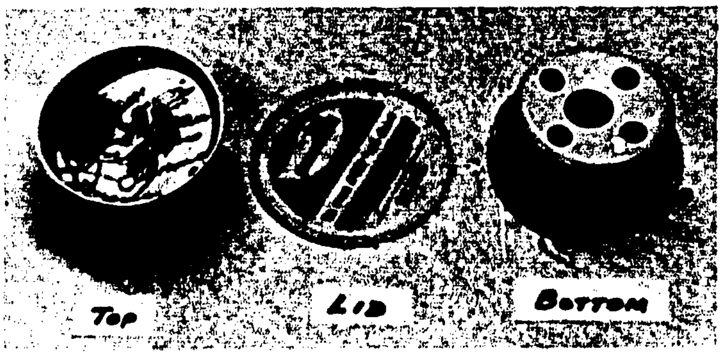


Fig. '1-13. Electronic Alarm System Parts
Switch devices can be heat sensors, or mechanical trips, or they can be operated manually.

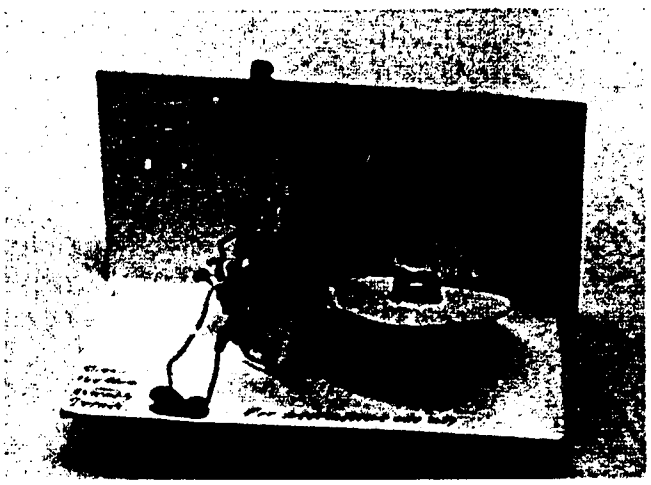


Fig. 61-14. Alternate Siren or Fire Alarm Arrangement

ASSIGNMENT 62, ACTIVITY 29
READING 6

Inputs to Manufacturing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to inputs to manufacturing:
   a. Describe how your life would change if the natural resources of wheat, petroleum, and trees were no longer available.
   b. Describe what would happen to manufacturing companies if all individuals took their savings out of the banks at one time.

Discussion

2. Given a presentation:
   a. Name the six basic inputs to the manufacturing process and give an example of how energy is used in manufacturing.
   b. State where natural resources are found.
   c. Name two types of labor activities provided by human resources.
   d. Name three kinds of knowledge that are needed in manufacturing.

Laboratory Activity

3. Given 20 pictures, correctly identify the *major input* to manufacturing that is represented in at least 16 of the 20 pictures.

Time Schedule

5 Overview
20 Presentation
10 Discussion
10 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 filmstrip projector/screen

Supplies

1 Filmstrip 62, *Securing Inputs to Manufacturing*

122

Overview (5)

This assignment concerns the inputs to manufacturing.

1. What are the *six basic inputs* to manufacturing. (Knowledge, capital, finance, human resources, natural resources, and energy.)

   How is energy used in manufacturing? (To heat or cool buildings, run machines in plants and offices, move materials, etc.)

   Where do natural resources come from? (Earth, sea, and air.)
2. I will show you a filmstrip about several of these inputs.
3. You will be asked questions about each of the inputs and we will discuss your answers.
4. In the laboratory activity, you will look at pictures about manufacturing and see if you can *identify* what *inputs* are represented.

Presentation (20)

This filmstrip presents the inputs to modern manufacturing that are needed before the production of goods can begin. The script emphasizes the *major* input represented in each frame.

Script for Filmstrip 62

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Securing Inputs to Manufacturing*
5. There are six kinds of inputs to manufacturing: *natural resources, energy, finance, capital, human resources,* and *knowledge.*
6. The building represents *capital input.* Equipment and tools used in the building are also capital inputs.
7. These workers are the *human resources* necessary for all manufacturing.
8. *Natural resources* are needed by all manufacturing industries. Cotton is an important input to plants that produce clothing and other textile products.
9. Money in this bank can be loaned to help *finance* the construction of a manufacturing plant.
10. Machines shown in this plant are *capital inputs.*
11. This man is monitoring automated equipment. Both *capital input* and *human resources* are illustrated.
12. This worker is securing latex from a rubber tree. This latex is a *natural resource* which will be an input to the manufacture of rubber products.
13. *Natural resources* such as this stone, being removed from a quarry, can be used in both construction and manufacturing industries.
14. This worker is using his *knowledge* of a slide rule to help solve a mathematical problem.
15. Gold and silver stored in this vault represent *finance inputs,* since they provide backing for our monetary system.
16. These hand tools can be thought of as *capital inputs* to the manufacturing process.
17. This hydroelectric dam supplies electricity, an *energy input* to many manufacturing plants.
18. Lumber, another *natural resource,* is an input for many manufactured products.
19. *Human resources* are one of the most valuable inputs to the manufacturing process. Safety programs are established to protect workers.
20. These domesticated animals provide a variety of valuable *raw materials.* Animals and plants are natural resources that will reproduce themselves if their environment is not spoiled.
21. This library is a storehouse for *knowledge.*
22. This man is using his *knowledge* of minerals to locate raw materials for the manufacturing process.
23. Oil and natural gas are *natural resources* that can furnish energy inputs to the manufacturing process.
24. This researcher is using her *knowledge* to conduct an experiment which may result in the discovery of new *knowledge.*
25. This atomic energy plant can be used to generate electricity, an important *energy input* to the manufacturing process.
26. Pleasant and efficient office personnel are in demand to perform the large amounts of clerical work needed in manufacturing. All workers are a *human resource* who apply *knowledge* in their jobs.

27. The people at this stockholders' meeting have invested their money to *finance* a manufacturing corporation.
28. Money invested by the stockholders can be used to buy heavy equipment, sometimes called *capital inputs*.
29. Here is an oil refining plant which has spent huge sums of money for *capital inputs*.
30. This planner relies on his technical knowledge to get the job done.
31. Electrical *energy* generated by an atomic energy plant must be transmitted to the manufacturing plant.
32. This classroom and equipment are *capital inputs* which will provide *knowledge* to employees.
33. Research activities which involve experimenting are used here to gain *knowledge*.
34. Many natural resources, such as coal, are extracted from the earth for use as an input to the manufacturing process.
35. Photographs courtesy of: IACP, Armco Steel, etc.

Discussion (10)

1. Where do natural resources come from? (Earth, sea, and air.)
2. How is energy used in manufacturing? (To heat or cool buildings, run machines in plants and offices, move materials, etc.)
3. What are the basic functions of finance and capital? (*Finance* provides the money necessary *to buy* buildings and equipment for a manufacturing plant. Once the buildings and equipment are *purchased*, they are referred to as *capital inputs*.)
4. *Human resources* provide what two types of work or labor activity? (*Physical*, as on an assembly line; and *mental*, as the researcher.)
5. Name the three kinds of knowledge or technology that are needed in manufacturing. (Management technology, personnel technology, and production technology.)

Laboratory Activity (10)

Following the discussion, have students identify the most obvious input represented by each photograph in the Laboratory Manual.

1. Have students work in groups of five.
2. Inform the students that *each picture has a brief caption* to be used as *cue*.
3. After students have finished, read the correct answers and have them circle the answers that they have wrong.
4. Have them use the scale to find their grades. See which group did best.

Homework

Reading 7, *Organization, Ownership, and Profit*

Answers for Laboratory Manual

1. Knowledge
2. Capital
3. Finance
4. Human resource
5. Natural resource
6. Energy
7. Human resource
8. Knowledge
9. Finance
10. Capital
11. Natural resource
12. Energy
13. Capital
14. Natural resource
15. Knowledge
16. Finance
17. Human resource
18. Energy
19. Natural resource
20. Capital

ASSIGNMENT 63, ACTIVITY 30
READING 7

Organization, Ownership, and Profit

Obj. tives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about organization, ownership, and profit:
   a. Discuss how your life would change if the federal government removed all *regulations* of *public utilities.*
   b. Explain a plan of action for winning the game of *Monopoly.*

Discussion

2. Given the textbook reading:
   a. Name *three types* of industrial organizations.
   b. Name *one advantage* and *one disadvantage of each type.*

Laboratory Activity

3. Given a list of suggested names for a new corporation, vote for one.
4. Given a written script, play a role in the functioning of a new corporation.

Time Schedule

5 Overview
15 Presentation - Discussion
25 Laboratory Activity

Overview (5)

Today's lesson deals with the *organization, ownership, and profit* of a corporation.

1. Your textbook explained that a company may be owned as a *proprietorship*, as a *partnership*, or as a *corporation.*
2. All manufacturing companies must *make a profit* if they are to continue to operate. A *profit* is the money a company makes by *selling* its products *for more than it costs* to design, manufacture, and market them.
3. We will discuss the *advantages* and *limitations* of a proprietorship, a partnership, and a corporation.
4. In the laboratory you will *play a role* in the functioning of a new corporation.

Presentation - Discussion (15)

The purpose of this discussion is to familiarize students with three types of business structures, and the advantages and limitations of each. The teacher may wish to solicit answers from students. Use the chalkboard where appropriate.

1. What is an industrial organization called if one man owns and operates everything? (Proprietorship.)
2. A *proprietorship* has advantages and disadvantages, or limitations.
   a. Name three advantages of a proprietorship (single owner):
      (1) He has complete control of the company.
      (2) He gets all the profit.
      (3) He can dissolve (end) the company when he wishes.
   b. Name a major limitation:
      (1) He may lose his personal property to pay the debts (expenses) of his company.
3. What is an industrial organization called if two or more people combine to form a company? (Partnership.)
4. There are advantages and limitations to a *partnership.*
   a. Name two advantages:
      (1) Same as proprietorship.
      (2) Everything must be shared equally: profits, losses, decisions, and company debts.
   b. Name a major limitation:
      (1) Both may lose their personal property or profits to pay the debts of the company.
5. What is an industrial *organization* called if it is owned by *stockholders* and is chartered by the government to become a legal body? (Corporation.)
6. There are advantages and limitations to a *corporation.*
   a. Name four advantages:
      (1) It can raise large amounts of capital.
      (2) Its shares of ownership can easily be given or sold to other people.
      (3) A corporation never dies.
      (4) Its owners cannot be made to pay for all of the debts of the company.

b. Name two limitations:
   (1) Since a corporation is an "artificial man," it has no *human* rights and responsibilities.
   (2) Through its charter and existing laws, its right and responsibilities are regulated by government in the public interest.

Laboratory Activity (25)

Today, students will participate in a role-playing situation for the purpose of learning how a manufacturing corporation can come into being.

1. Have students *choose a name* for the corporation *by voting*. Place this name on the chalkboard.
2. The script is broken down into four sections with roles for students as follows:
   Group 1. Board of Directors & Investors — nine students
   Group 2. Engineering — four students
   Group 3. Production — nine students
   Group 4. Personnel — five students
   Use your own judgment on the following alternatives:
   a. Assign *one* of the roles in the script *to each student.*
   b. Place students into the four groups and ask a group leader to assign appropriate roles to members of his group. See Fig. 30-1 in the Laboratory Manual.
3. Students may read the *script as it appears* in the Laboratory Manual. Another possibility is to allow students to relate their job description to what they will actually be doing in the shop during the next two weeks. If you follow this route, you should allow students a few minutes to determine some of the specific responsibilities they will assume in future activities.
4. After the role-playing activity, have students answer questions in the Laboratory Manual.

Homework

Reading 8, *Identifying Consumer Demands*

Answers for Laboratory Manual

1. Answers will vary.
2. Answers will vary.
3. Corporation.
4. False.

ASSIGNMENT 64, ACTIVITY 31
READING 8

Identifying Consumer Demands

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to identifying consumer demands:
   a. Discuss how you would inform a manufacturer that you don't like his product.
   b. Determine if your parents have been involved in a consumer study and, if so, the *type* of study and *where* it took place.

Discussion

2. Using the data gathered during the laboratory activity, decide what the data mean to a company considering production of the product.

Laboratory Activity

3. Using the forms provided, conduct an in-class consumer survey, tabulate the data, and complete a market research report.

Time Schedule

5 Overview
5 Presentation
20 Laboratory Activity
15 Discussion

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 Transparency 64, *Consumer Survey Form*

Overview (5)

Today's lesson concerns identifying consumer demands.

1. The textbook described a consumer and the effects of consumer demands on manufacturing.

126

2. I will show you an example of a common type of consumer survey form.
3. During the laboratory activity you will *conduct a consumer survey* to gather information about a product the class might produce and sell.
4. After conducting the consumer survey, you will *tabulate the results.*
5. The tabulated data will be used to *complete a Market Research Report.*
6. After the Market Research Report is completed, we will discuss some *questions* that the consumer research department of a company *must answer before proceeding* to manufacture a product.

Presentation (5)

Look at the list of potential products, Fig. 61-1. Select two or three products that have the most promise for your group and laboratory situation. Write the two or three selections on the chalkboard. The consumer survey should help in the selection of the final product. *Products should not have more than three or four parts.*

Consumer demands determine what and how much will be manufactured. Consumer surveys are often used in market research.

1. Show Transparency 64, *Consumer Survey Form.* This is an example of a typical consumer survey form.
2. Consumer surveys are often conducted by interviewers.
3. Sometimes the forms are packaged with a product. In this case, the consumer is asked to complete the form and return it to the manufacturer.
4. Most consumer survey forms are short and easy to complete.
5. The consumer is usually asked to *respond* to the items *by checking* one of several suggested answers. (Demonstrate by checking several items on the transparency.)
6. Some surveys are *conducted at an early stage of design* to find out in a general way who might buy and what they want. Other surveys are conducted after designs are perfected to help *choose between alternate* design solutions.

Laboratory Activity (20)

The students are to *conduct* a consumer survey, *tabulate* the data, and *complete* a market research report.

1. Students will work in groups of five.
2. When all groups have tabulated the data for their groups, a *composite tabulation* should be made on the chalkboard.
3. Groups will fill in the Market Research Report, using the data on the chalkboard.
4. After completing the Market Research Report, the class will discuss the implications of the report for production of the selected product.

Discussion (15)

The data from the Market Research Report must be *interpreted* to be useful to the manufacturer. The market research department must *answer certain questions* about the report. We will attempt to answer some of these questions, using the data we gathered in class today.

1. What group of people would make the best market for the product? (See Items 1 and 2 of Market Research Report.)
2. What is the potential market for the product? (See Items 3, 8, 11, 12, 13.)
3. Can a trend in sales be determined from the data provided? (See Items 3, 4, 5, 6.)
4. Is there any indication that the consumer will prefer our product over others on the market? (See Items 4, 5, 6, 7, 10.)
5. How will competition affect our product? (See Items 4, 5, 6, 7, 10.)
6. What percentage of the total market can we expect? (See Items 4, 5, 6, 7, 10.)
7. Assume that we need to sell a minimum of 30 units, at $.60 each, to make a profit. Will business volume be large enough to return a profit? (See Items 9, 10, 11, 12, 13.)
8. Have students decide on *one* simple product to produce.

Homework

Review Reading 10, *Designing Manufactured Goods*

Note

Look ahead to Assignment 65, Laboratory Activity, Item 1, to make up a set of limitations for the product selected today.

ASSIGNMENT 65, ACTIVITY 32
READING 10

Designing Manufactured Goods

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a demonstration on the design process, identify four steps followed to develop a product design, starting with a rough idea.

Laboratory Activity

2. Given the problem of designing a selected product:
   a. Prepare *rough sketches* based on limitations and specifications.
   b. Develop a *refined sketch* from rough sketches and specifications.

Time Schedule

5 Overview
10 Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Supplies (Group of 5)

10 shts. 8½″ x 11″ sketch paper*
10 shts. 8½″ x 11″ tracing paper*
1 file folder
*Have additional paper available.

Overview (5)

1. Earlier in the course when you designed the LSRAV, you studied the procedures of *creating alternative designs.* You learned that the product designer prepares various kinds of *sketches* and *mock-ups* to help him *evaluate* tentative solutions to a problem.
2. Today I will review some techniques that a designer uses to create alternate design solutions: the *thumbnail sketch,* the *rough sketch,* and the *refined sketch.*
3. You will be asked to *identify four steps* followed by the industrial designer as he develops a product design from a rough idea.
4. In the laboratory activity you will have an opportunity to make *rough sketches* of the product selected by the class and refine your best design idea.

Demonstration (10)

In this demonstration, design development will be reviewed.

1. Many simple sketches, called "thumbnails," start the product design. (Show on the chalkboard how to sketch three candlestick designs: a circular design, a horizontal rectangular design, and a vertical rectangular design. Make quick rough sketches in a very simple style. See Fig. 65-1. If more than one is desired, thought can be given to making up sets as in Fig. 65-1.)
2. Rough sketches are prepared showing various "thumbnail" ideas more carefully. (Show on the chalkboard how a very crude "thumbnail" idea is resketched, keeping the idea but developing it into a recognizable rough sketch. Also show how to "pick up" part or all of a sketch by laying tracing paper over a drawing and tracing whatever is worth copying.)
3. Of the possible roughs, a single design seems to hold the most promise. (Choose the vertical rectangular candlestick design.) The designer then makes a refined sketch of this selected design. See Fig. 65-1.

Discussion (5)

1. What are the preliminary sketches of a product design called? (Thumbnails.)
2. How are thumbnails used? (The ideas are worked up into rough sketches.)
3. How are rough sketches refined? (They can be resketched or traced, to show details accurately.)
4. How does a designer get an idea of the general shape and bulk of the design solution? (A mock-up is used.)
5. Why are crude, free-hand sketches valuable? (Because they capture ideas.)
6. Why do designers keep many thumbnails and unfinished rough sketches? (Product designers refine many ideas to reach one final solution.)

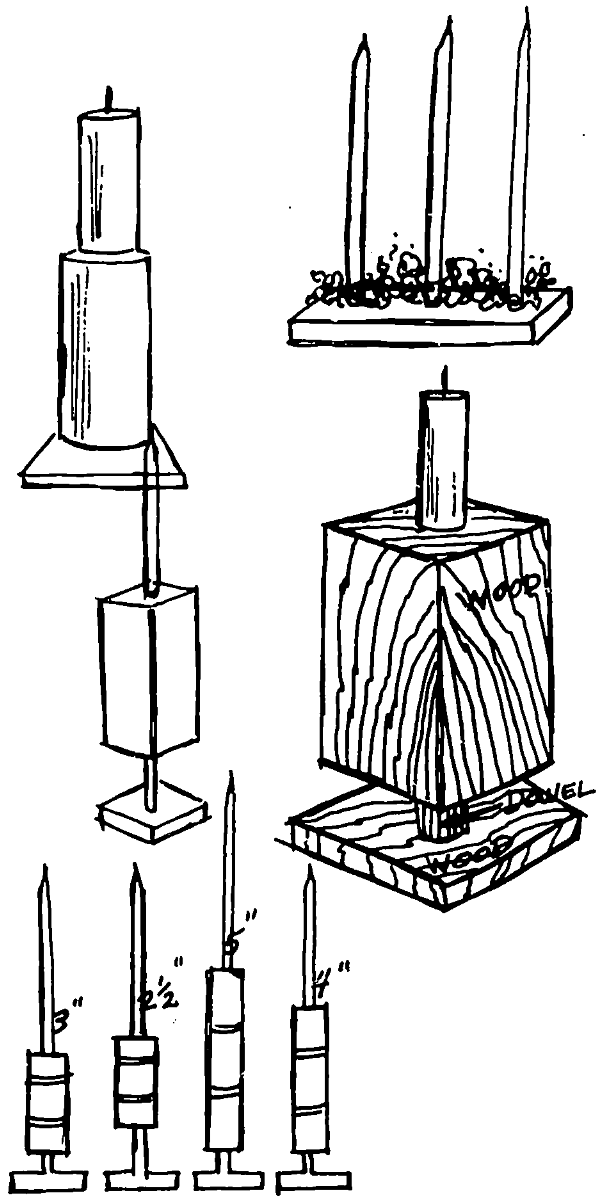


Fig. 65-1. Rough Sketches

7. What are four design steps followed by the industrial designer? (Thumbnail sketches, rough sketches, refined sketches or drawings, mock-ups.)

Laboratory Activity (25)

Today the students will prepare rough sketches for their selected product and refine one rough.

1. Make up a set of general limitations for the product selected yesterday. These should include the kinds of materials, size, general shape, number of parts, color, etc. that you select. Record the limitations on the chalkboard.
2. Prepare the supplies for distribution to groups of five.
3. Working from thumbnail sketches and limitations from the demonstration, students will sketch several rough design ideas.
4. Next, each student will resketch or trace his best design and refine it. Students may use tracing paper to "pick up" parts of several designs.
5. You may wish to have group members *compare alternate designs* and *choose one outstanding design* within their group. Each student may then trace the chosen design, so he will have a copy.
6. Each student will sign and date his sketches in the lower right-hand corner.
7. Each recorder will collect and file sketches, and turn in the file folder.
8. NOTE: The teacher will need to look at the sketches and determine the *specific sizes* of parts and materials for use in the next activity, Making Working Drawings.

Precaution

Care should be taken in tracing a design; tracing paper is thin and will tear easily.

Homework

None, or review Reading 17, *Making Working Drawings*

ASSIGNMENT 66, ACTIVITY 33
REVIEW READING 17

Making Working Drawings

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Using the information provided, prepare a set of working drawings for the product.

Time Schedule

5 Overview
5 Presentation
35 Laboratory Activity

Supplies for Presentation

Supplies

1	assembly drawing
1	two-view drawing of a part
1	detail drawing
1	electrical schematic (if the product is electrical)

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5	12″ rules

Supplies (Group of 5)

10 pcs.	8½″ x 11″ grid paper, ¼″ squares
5	pencils
1	file folder

Overview (5)

1. In the last assignment you refined your rough sketches of the product we will make.
2. Today you will work on the parts that make up our product.
3. I will show you the basic ideas that influence the manufacture of the product.
4. I will review some of the basic information on working drawings which you used earlier in the year when you made working drawings for the Land Speed Record Assault Vehicle.
5. During the laboratory activity you will draft a set of working drawings for the product components. You will make a two-view assembly drawing, a detail drawing, and a parts list showing materials needed to manufacture the product.

Presentation (5)

1. Show the assembly drawing and two-view drawing.
   a. This is an assembly drawing. It shows all of the parts and how they are put together.
   b. It is also a two-view drawing. Note the top view is shown directly above the front view.
   c. In order to build this product, additional information and drawings of the various parts must be provided.
2. The overall dimension can be shown on the assembly drawing.
   a. The *extension lines* extend from the object.
   b. The *dimension lines* are placed between extension lines.
   c. The *arrowheads* show the endpoints of the dimensions.
   d. The *numerals* represent the value or distance in inches.
3. Show the detail drawing. A detail drawing is needed for each component. These parts cannot be dimensioned easily on the assembly drawing. Point out the component, dimensions, and notes.
4. A systems or *schematic* drawing is often used to show how one part functions in a system of parts. Point out the schematic symbols and parts.

Laboratory Activity (35)

Today students will prepare a set of working drawings for their product. The set of drawings will include: an assembly drawing consisting of a top and front view; detail drawings of the parts; necessary dimensions and notes; and a parts list.

1. List and draw the specific limitations (size, shape, material) for each component on the chalkboard. Point out the details related to each component.
2. The students will work in their regular groups.
3. Students will use their own refined sketches (depending upon the teacher's directions) to develop their sets of drawings. *Each part should be numbered.*
4. The students in each group will work together in checking the dimensions and materials to be used.
5. Each student will draw a rough assembly

drawing and a detail of one of the components.

6. The group should then complete a parts list form in the Laboratory Manual. A copy should be kept by the teacher for reference in ordering materials.
7. Each student is to sign and date his drawings. The drawings should be filed together in a folder for use during the production days.

Homework

None, or review Reading 18, *Building the Production Prototype*

Note

1. Make up group assignments for Laboratory Activity 34.
2. Prepare materials for demonstrations and laboratory activities.

ASSIGNMENT 67, ACTIVITY 34
REVIEW READING 18

Building the Production Prototype

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

Given the necessary materials and equipment, manufacture components and subassemblies for prototypes of the product.

Time Schedule

5 Overview
15 Demonstration
25 Laboratory Activity

Equipment and Supplies for Demonstration and Laboratory Activity

Equipment

As needed.

Supplies

As needed.

Overview (5)

1. So far, you have been concerned mainly with the planning of the product. Today you will test some of your plans to see if they work. We will see what processes need to be done to make the product.
2. I will demonstrate some of the general processes that you will be performing in the laboratory today.
3. I will assign members of the class to work groups. Each group will fabricate a part or subassembly of the product to be used in making two prototypes.
4. During the laboratory activity you will produce parts for two production prototypes of the product.

Demonstration (15)

Have equipment and materials ready before class. Demonstrate some of the more difficult operations that will be needed to produce the product.

Laboratory Activity (25)

Students will fabricate parts and subassemblies for two production prototypes.

1. Assign members of the class to groups according to the number of parts and operations needed to be performed.
2. Point out where each group should begin.
3. Have materials ready for each group.
4. Check the first piece produced by each student to see that directions have been followed.
5. Move from group to group to demonstrate any operations with which students are having difficulty.
6. Be prepared to store parts for use in ACTIVITY 37B.

Safety Precautions

Point out any hazards, precautions, and safety procedures.

Homework

Review Reading 20, *Planning Production*

ASSIGNMENT 68, ACTIVITY 35
REVIEW READING 20

Planning Production

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the term "product analysis," name the kinds of information obtained by product analysis.
2. Given the term "production flowchart," explain what it is.

Laboratory Activity

3. Given the drawings, specifications, and operations necessary to produce a product:
   a. Determine alternate ways of doing operations.
   b. Select ways for performing operations, inspecting and transportation of equipment within the laboratory.
   c. Develop individual component and subassembly flowcharts.
   d. Develop an overall production flowchart.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5	12″ rules
1	production prototype
2 pr.	scissors
	prototype components

Supplies (Group of 5)

40 shts.	8½″ x 11″ paper
6	folders to store operation sheets
1 roll	transparent tape

Supplies (Per class)

1 pc. Kraft paper 36″ x 60″

Overview (5)

For the past few days you have been working with our product.

1. Today's reading described the *planning* that is required *before production* of a product can begin.
2. We will discuss how management chooses the production processes that will be used to make a product.
3. In the laboratory activity you will *determine different ways of performing processes* with the equipment in this laboratory. Then each of you will help *develop a flowchart* for producing one component or subassembly, and the charts will be combined into one master flowchart.

Presentation (5)

1. A manufacturer must plan the production processes that he will use to make a new product. To do this, he analyzes the product.
2. Planning production processes is a major step between designing a product and starting to make it. The basic processes must be chosen, and the operations needed to make each component must be chosen.
3. The drawings and specifications for the prototype for the product must be analyzed to determine what production processes will be required.
4. After the required production steps are determined, the production planners decide whether to make or buy various components.
5. For any one process there may be alternate ways of doing work. After they study these alternate ways of doing work, the industrial engineers decide which way best suits the company's resources. They must think of time, equipment, and costs.
6. A production planner then arranges all the selected operations in the order in which they will be performed, and prepares a *production flowchart*. Several kinds of symbols and abbreviations are used to show the operations.
7. This flowchart is studied. The time and cost requirements of each operation must be considered. The operations also must be checked against the design specifications.
8. This study may result in revising the production flowchart.

Discussion (5)

Today we are concerned with planning production processes. This involves the development of a production flowchart. The following points can be raised in relation to production planning:

1. What is product analysis? (Studying how to make a product.)
2. What do you look for in product analysis? (What materials are required? What work on materials is required? How will the work to be done? What is the best process for completing operations under certain conditions and with certain equipment?)
3. What is a production flowchart? (A graphic record or "picture" showing the order of steps in each process.)
4. How is the production flowchart developed? (Through product analysis, the work to be done is identified and organized, operations determined, best manufacturing processes determined, and related activities determined.)

Laboratory Activity (30)

Today students will analyze a product and develop an initial production flowchart.

1. Students are to work in groups of five. Assign each group a component.
2. Distribute paper to each student.
3. Point out where various kinds of information are to be found.
4. Move about the room, observing activities and answering questions.
5. Have Kraft paper ready for taping completed process flowcharts in place to make the master flowchart. When all groups are ready, supervise the building of the production flowchart.

Safety Precaution

Safety must be planned for, in any production system, by considering employees' limitations and work habits.

Homework

Review Reading 25, *Tooling Up for Production*

Notes

1. Prepare a sketch of the industrial arts laboratory layout for production of the product. Note placement of machines, tools, benches, and any possible use of a conveyor system. Any tools or equipment that must be shared will need to be mentioned to students before they set up for a trial run. This information will be used for the presentation, Assignment 69.
2. Prepare a list of work stations from the flowchart and a system for assigning students in each class to a particular work station. It is suggested that students from a group that developed the flowchart for a particular part be used to set up the production line for that part.
3. Have necessary starter materials, tools, equipment, and conveyor systems ready for starting each class.

ASSIGNMENT 69, ACTIVITY 36
REVIEW READING 25

Tooling Up for Production

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given flowcharts, equipment, and supplies:
   a. Set up the production system for making the product parts.
   b. Conduct a trial run.
   c. Complete a Job Description Sheet. (Optional)

Time Schedule

5 Overview
10 Presentation
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

See ACTIVITY 34. Today's equipment needs will be the same, unless changes were made.

Supplies (Class)

See ACTIVITY 34. Today's supplies will be the same. The class will also need:

2 sets	pattern pieces, from ACTIVITY 34
all	process flowcharts, from ACTIVITY 35
1	master flowchart, from ACTIVITY 35

Overview (5)

1. The textbook explained that engineers are responsible for tooling up. They make important decisions about the *selection and placement of tools and equipment* so that efficient production will be possible.
2. Today you will *set up the production system* for the product and conduct a trial run.
3. First, we will discuss how we can best arrange the equipment so that we will have an efficient production system. (NOTE: This needs to be discussed even though the equipment may be set up only once each day.)
4. We will then set up the equipment, and conduct a trial run to see if our production system will work efficiently.
5. You will be assigned a particular job in the production system.
6. If there is time at the end of the trial run, each student will fill out Fig. 36-1, Job Description Sheet.
7. Be sure to follow safety procedures when you are operating the machines.

Presentation (10)

1. Tooling up for production includes several steps:
   a. Deciding what *existing machines,* tools, and equipment will be needed.
   b. Selecting all *standard machine* tools and equipment.
   c. Designing and ordering machines, tools, and equipment that must be *specially made.*
   d. Supervising the *installation* of machines and equipment, the start-up, and the trial run of production.
2. For your product, some of these tooling-up activities have already been accomplished in previous laboratory activities.
3. Careful planning is important. Without it, materials might not move efficiently from station to station.
4. Look at the master flowchart that was completed previously. It shows the sequence in which the machines will be used in the production system.
5. Workbenches also must be arranged, so that the materials will move efficiently from one work station to the next. (Draw a sketch of a floor plan on the chalkboard, illustrate the positions of workbenches, the machines, and work stations. Discuss the proper placement of equipment.)

Laboratory Activity (30)

1. Direct the class in preliminary setup activities:
   a. Moving workbenches into place.
   b. Placing equipment, conveyor systems, and supplies in the proper sequence. (NOTE: Equipment will probably be placed only once by one or two of your classes at the beginning of the day.)
2. When the production system has been arranged, assign students to their work stations.
3. Check to see that the proper equipment

and supplies are ready at each work station.
4. Begin the trial run by starting a workpiece for each part through the system. Follow the process, step by step. Give instructions when necessary. Watch the students to be sure that they follow the safety precautions.
5. If the trial run discloses any need for modifications, help students decide the needed changes. Changes must be noted on the appropriate flowcharts.
6. If time permits, have each student fill out his Job Description Sheet.
7. Each student is to file his sheets and flowchart.

Safety Precautions

1. Keep fingers away from cutting edges.
2. Wear safety glasses.
3. Do not disturb students who are operating machines.

Homework

Reading 27, *Operating Quality Control Systems*

ASSIGNMENT 70, ACTIVITY 37 READING 27

Operating Quality Control Systems

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to operating quality-control systems:
   a. List products which would be tested by destructive and nondestructive testing.
   b. Discuss why it is *not* necessary to inspect every mass-produced product and what would happen if this was necessary.

Discussion

2. Given a production situation, explain:
   a. Why product units coming off a production line are alike.
   b. The characteristics of interchangeable parts.
   c. The importance of quality control.

Laboratory Activity

3. Given the problem of producing interchangeable parts for a product and the production planning experiences, develop needed gages and quality control devices for use on the production line.

Time Schedule

5 Overview
15 Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1	overhead projector/screen
1	production prototype of products, from ACTIVITY 36
Several	examples of gages and measuring devices: drill gage, calipers, micrometer, sheet metal or wire gage, etc.

Supplies
1 set Transparencies:
70-1. *Four Conditions of Specifications*
70-2. *Tolerance*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)
As needed

Supplies (Group of 5)
As needed, wood and metal scraps

Overview (5)

1. You have read about the *three main steps* in a system of quality control:
   a. *Monitoring or inspecting* the product.
   b. *Reporting* the results of inspection.
   c. *Correcting* whatever needs to be changed in the production system.
2. I will explain *four conditions* that are tested in fabricated products:
   a. Size.
   b. Shape or form.
   c. Positional relations.
   d. Conditions of assembly.
3. We will then discuss how a *quality-control* system makes mass production possible and the effects this system has on industry and our society as a whole.
4. Today you will study *tolerances* and their *importance* in quality control. I will explain why variations in size exist and why this variation is important.
5. *Minimum clearance* or *allowance* between mating parts will be explained while showing transparencies.
6. During the laboratory activity you will *produce simple gages* and quality control *devices* for use with inspections on the production line.

Presentation (15)

Specifications for mechanical products are interpreted in terms of four conditions.

1. Show Transparency 70-1, *Four Conditions of Specifications.*
2. Three conditions are controlled while a product is being fabricated or processed: size, shape or form, and positional relations.
3. The conditions we call "size" answers questions such as: How big? How long? How deep? How thick? (Relate these characteristics to the product.)
4. The condition called "shape" or "form" answers questions such as: How flat? How rough? How smooth? A shape may be described as round, cylindrical, straight, conical, spherical, etc. (Relate these characteristics to the product.)
5. The condition of positional relations has to do with alignment, squareness, parallel edges, perpendicular edges, spacing of holes, etc. (Relate these characteristics to the product.)
6. The end-process condition concerns assembly or function. It answers such questions as: Will it assemble? Will it work? Will it last? A number of things must be checked on the product. (Relate these characteristics to the product.)
7. You have learned that all parts vary in measurement, because there is no such thing as an exact size. However, in most manufactured products, variations are so small (usually in thousandths of an inch) that at first it is hard to understand their importance. It is also difficult to visualize a thousandth of an inch. Yet some variability in the size of a dimension always occurs. It is important to know what may cause variation.
8. When quantities of a part are being made, there are always some variations in size. Machines wear, operators make errors, and materials vary. The amount of variation in part size that can be accepted depends on how the part will be used. This acceptable amount of variation is called *tolerance*. The design engineer specifies the tolerance for a part.
9. Show Transparency 70-2, *Tolerance*. "Bilateral" means two-sided. For bilateral tolerance, the permissible variation can be either larger or smaller than the basic size. The length of the ______ (your part number and name, for example) is supposed to be ______". But if it is 1/16" longer or 1/16" shorter, it will/will not work when assembled.
10. "Unilateral" means one-sided. For unilateral tolerance, the permissible variation can be in one direction only. For example, the width of ______ (give two part numbers and names) must be at least ______" wide so that two will fit together. It could be 1/16" or more larger/smaller.

11. A tolerance concerns *one* dimension of *one* part. (Emphasize.)
12. The planned or intentional difference between two mating parts is a *clearance space*. Note the clearance between ____ ____ (give example of two parts that fit together.)
13. The minimum or smallest clearance space between two mating parts is also called *allowance*. The engineer plans this allowance in advance; it is part of the product design.
14. The engineer is responsible for matching the amount of the allowance between two mating parts and what they are designed to do. Between parts ____ and ____, the allowance is small.
15. The acceptable amount of tolerance or size variation for *one* part depends on the clearance designed between *two mating* parts. If two parts must fit together precisely, then the tolerance will be small.
16. To assure that a finished product has acceptable quality, it must undergo some kind of inspection. Special measuring devices called *gages* are often used to inspect products on the production line.
17. A *fixed gage* is one that is finished to the exact size and cannot be adjusted in any way. Examples of fixed gages are go-no-go gages and plug gages.
18. An *adjustable gage* is one that can be adjusted to any limiting dimension within a given general size range. (Show examples.)
19. Today you will *develop measuring devices* for quality control inspections on the product production line.

Discussion (5)

1. Any two components of a product coming off the same production line are very similar in all their dimensions. Why? (The parts are mass-produced, and they are made by duplicating or reproducing a prototype.)
2. What would happen if they weren't alike? (Interchangeable parts would not be possible.)
3. Is interchangeability a characteristic of custom-made products? (No, each part must be individually fitted.)
4. How does a manufacturer assure interchangeability of parts? (Through a quality control system.)
5. In quality control systems, what is the purpose of inspection? (To examine a part or product critically. To make sure it meets its standards of quality, as specified by the designer.)
6. Do inspections reduce the amount of waste in production? (Yes.) Explain. (Faulty production is kept low because it is discovered early.)

Laboratory Activity (20)

Today's activity will be directed to the problem of insuring the quality of our manufactured product.

1. Students will work in their regular groups.
2. The groups will focus on *designing* and *making devices* to control the quality of product parts.
3. Help students select the control devices that are most needed.
4. Store the gages and devices for later use during production.

Safety Precautions

1. As needed to suit the situation.
2. In destructive testing, be sure proper safety provisions and equipment are used.

Homework

Reading 23, *Measuring Work*

Note

Equipment should be movable to fit the arrangement needed for getting ready for production.

ASSIGNMENT 71, ACTIVITY 38
READING 23

Measuring Work

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to measuring work:
   a. Determine the average time over a week it takes your family to wash dishes. Time the process every evening for a week from the moment the table is cleared until the last dish is put away.
   b. List reasons why labor unions and management disagree over *work measurement* processes and how these disagreements are settled.

Discussion

2. Given a series of questions on work measurement:
   a. State how much work should be included in timing an operation.
   b. Describe how to use a watch for timing an operation or work activity.

Laboratory Activity

3. Given the necessary equipment, supplies, and specifications, find the processing time for fabricating each component of the product.

Time Schedule

5 Overview
10 Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Demonstration

Equipment

1 overhead projector/screen

Supplies

1 Transparency 71, *Time Study Observation Chart*

Equipment and Supplies for Laboratory Activity

Equipment (Class)

As needed

Supplies (Class)

As needed

Overview (5)

1. I will demonstrate how to measure the time required to perform various operations.
2. You will be asked to identify what is involved in timing work operations.
3. In today's laboratory activity you will determine the standard time necessary to produce each component of the product.

Demonstration (10)

Today the teacher will show how to time an operation and how to complete a time study chart. (NOTE: Before class, set up the equipment for demonstrating one operation for one component.)

1. Choose one student from each group to serve as timekeeper for today's activities. (Group assignments will be the same as usual.)
2. Each timekeeper should have a watch with a second hand.
3. Explain the technique of timing an operation.
4. Have the timekeepers measure your performance time. Repeat the operation, if necessary, until they can measure accurately and understand the task.
5. Using Transparency 71, *Time Study Observation Chart*, record several numbers in the column headed "Operation 1" and explain that this is how they will record observed performance times.
6. Demonstrate how to complete Fig. 38-1, Items A-E.
7. Using the transparency, show how to compute the allowance time. (Multiply the cycle time by 20% or .20.)
8. Show how standard time is found by adding the cycle time and the allowance time.
9. Demonstrate how to figure transfer time.
10. Show how to figure total processing time.

Discussion (5)

1. Should the activities or operations to be timed be listed before actual timing or during timing? (Before.)
2. How much work should be included in each operation that is to be timed? (Enough to get a representative sample or to complete the operation.)
3. How do you determine exactly when to start and when to stop timing an operation? (Start when the student begins work on the operation, and stop when all the work is complete.)

Laboratory Activity (25)

The purpose of this laboratory activity is to determine standard time for processing each component of the product.

1. Group students for the tasks you will list in the table below: (Assign components, numbers, and part names.)

   Timekeepers from Groups 1-5: Find processing time and fill in the operations for their group in Fig. 38-1.
2. Students will perform the work tasks described on the appropriate Operation Sheet from ACTIVITY 35. Where possible, they should take turns.
3. Timekeepers are to time operations carefully and record their data first on a blank sheet of paper before entering figures on the Time Study Observation Chart, Fig. 38-1.
4. Circulate among the groups as they perform the laboratory activities, observing the work, answering questions and, if necessary, demonstrating how to perform operations.
5. Allow time for timekeepers to complete all calculations.
6. Supervise the cleanup.
7. Record and total the processing times for each component on the chalkboard.

Safety Precautions

1. Make sure that machines are used properly.
2. Student operators on machines should wear safe eye protection.

	CLASS PERIODS				
Group	1	2	3	4	5
1					
2					
3					
4					
5					

Homework

Reading 24, *Estimating Cost*

Note

The teacher will need to estimate the cost of materials for each component and have these figures available for the next activity. These will be recorded in Fig. 39-3 in the Laboratory Manual.

ASSIGNMENT 72, ACTIVITY 39
READING 24

Estimating Costs

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to estimating costs:
   a. Explain why *estimators* are especially important to shops that do contract work.
   b. List jobs in your community which have a low and high fatigue allowance.

Discussion

2. Given that estimating cost is important, identify two of the most important reasons.
3. Given that three kinds of direct cost are included in an estimate of manufacturing cost, name the three kinds of direct cost.

Laboratory Activity

4. Given cost estimate charts and needed data, *compute* the total production *cost* of the product.

Time Schedule

5 Overview
10 Presentation
10 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen
1 felt pen

Supplies

1 Transparency 72, *Total Cost Estimate for a Product*

Overview (5)

1. The textbook reading explained that cost estimates predict or forecast what the cost will be for something that has not yet been done.
2. I will explain some uses of production cost estimates and explain three kinds of cost estimate charts.
3. You will be asked to suggest how overhead costs can be estimated, state two reasons for estimating costs, and name three kinds of direct cost used in calculating cost estimate.
4. Today you will work as a class to *estimate* the total production *cost* of our product.

Presentation (10)

Today the class will learn how to use data assembled from their process planning and work measurement studies to estimate the total production cost of our product.

1. Production planning engineers need cost estimates. (Briefly explain how production planners use cost estimating.)
2. The selling price set for the product must take care of several kinds of costs. (Discuss each of these briefly.)
   a. Material costs
   b. Cost of labor
   c. Overhead: this will include cost of supervision, taxes, equipment, depreciation, inspection, sales, etc.
   d. Profit, paid to stockholders as dividends
3. There is an hourly wage chart in the Laboratory Manual. (Refer students to Fig. 39-1.) If we add the wage rates for the four kinds of production workers, and divide by four, we get an *average* hourly rate. (On the chalkboard record the sum ($12.00) and show how to find the average: $12.00 ÷ 4 = $3.00 average wage.)
4. To change an hourly rate to a rate per minute, we need to divide by 60. (On the chalkboard show that $3.00 ÷ 60 = $.05, which is the labor cost per minute.) This is one of the cost figures needed for today's activity.

Discussion (10)

1. On the average, overhead cost is just about equal to the total direct manufacturing cost. How would you use this fact to estimate the overhead cost? (Total all direct costs of manufacture. Use this total as the overhead figure.)
2. In production of the selected product, what will the direct manufacturing costs include? (The cost of materials and the cost of labor.)
3. What are the most important reasons for estimating costs? (To decide on the selling price. To choose the least costly production processes, where a choice is possible.)
4. What are the three kinds of costs with which you are working in this cost estimate? (Material costs, labor costs, and overhead.)

Laboratory Activity (20)

The class will work as a group in today's activity. Have your material costs per component available for use.

1. Work through the three cost estimate charts, step by step, with students.
2. The total processing time per product unit is to be obtained from the previous activity.
3. As the students compute each total, write their figures on Transparency 72, *Total Cost Estimate for a Product.*
4. Explain each step carefully, so that each student will understand how the various costs are computed.
5. When the charts are completed, have students answer the questions in their Laboratory Manuals.

Homework

Reading 35, *Hiring and Training*

ASSIGNMENT 73, ACTIVITY 40
READING 35

Hiring and Training

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to hiring and training:
   a. Explain why an employer would want to look at an applicant's school transcript before hiring him.
   b. Discuss how you might learn the wrong things if you were getting on-the-job training from an experienced employee.

Discussion

2. Given a series of questions:
   a. Name the three basic steps in hiring new employees.
   b. Explain the difference between within-plant recruiting and out-of-plant recruiting.
   c. Name some techniques and devices for selecting workers.

Laboratory Activity

3. Given an employment application form, complete the form as indicated and *compete for a job.*
4. Given several job applicants, help *choose the one best qualified* for the job opening.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 set Transparencies:
73-1. *Requisition Form*
73-2. *Job Advertisement*
73-3. *Employment Application*
1 newspaper with classified ad section

Overview (5)

The lesson today concerns hiring and training.

1. The reading described the hiring and training practices of manufacturing personnel technology.
2. I will describe these practices in more detail and prepare you for your laboratory activity.
3. You will be asked to play the role of a personnel director or a job applicant, and take part in hiring activities.

Presentation (5)

In the reading assignment you learned that hiring and training are important parts of personnel technology. Today we will talk further about hiring.

1. There are three basic steps in hiring: the company *recruits* job applicants, *selects* the person best suited for a job, and *inducts* the new employee.
2. *Recruiting* usually is done by advertising a job vacancy, so that workers can apply for it.
3. Show Transparency 73-1, *Requisition Form.* In large companies a *personnel requisition form* is filled out and sent to the personnel director. It describes the job to be filled, the major duties of the job, the experience and education that the job applicant will need, and the wage or salary to be paid.
4. The job vacancy may be advertised *within the plant* on a bulletin board or *outside the plant* in a classified newspaper ad. Show students the classified section of a newspaper and the specific classified ad illustrated on Transparency 73-2, *Job Advertisement.*
5. People who are interested in the job usually are asked to fill out an *application form.* Show Transparency 73-3, *Employment Application,* and briefly discuss it.
6. The next step in hiring is *selection.* First, the personnel director interviews all the applicants who appear to be well qualified for the vacant job. Their references — the people for whom they have previously worked — are checked. Quite often the applicants are given tests to measure special skills or abilities. After considering all data, the best-qualified applicant is offered the job.
7. After an applicant accepts a job offer, he is *inducted* into his new job. He talks with his supervisor. The company poli-

cies and benefits are explained. He meets his fellow workers. All of this is sometimes called *job orientation.*

Discussion (5)

1. What are the main steps in hiring? (Recruiting job applicants, selecting one person, and inducting him into his job.)
2. What is the difference between within-plant and out-of-plant recruiting? (Within-plant recruiting involves advertising jobs on company bulletin boards, in company papers and magazines, etc. Out-of-plant recruiting means advertising jobs in community papers, magazines, and through radio and television announcements, etc.)
3. What techniques and *devices* are used to *select workers* for specific jobs? (Application forms, interviews, references from previous employers, tests, etc.)
4. How does a company go about *inducting* a new worker into a job? (*Introduce* the worker to his supervisor and fellow workers; *instruct* him about company policies and benefits; *orient* him to the facilities of the plant.)

Laboratory Activity (30)

Today's role-playing activity is in two parts. The first has to do with *recruiting;* the second has to do with *selecting* the best-qualified applicant.

Problem 1

1. Divide the students into groups of five. Have each group foreman appoint a personnel director.
2. Read the "job ad." (Fig. 40-1 in Laboratory Manual.)
3. Tell students they are to pretend that they are high school graduates.
4. Allow 10-15 minutes for students to fill out the employment application form, Fig. 40-2, for the "job ad."

Problem 2

5. Seat students as one group, preferably in a circle. Set up two chairs for interviews. At this point each "personnel director" should have decided which person he will recommend for the job.
6. Have each group's personnel director present and interview his applicant. Limit each interview to two minutes or less.
7. You may want to play the role of personnel director for the first interview to give the students ideas about the types of questions to ask. You may want to be more specific as to the major duties of the applicant. If so, try to make these relate to the operations used in making the components for the product.
8. After all groups have participated, have those who were interviewed leave the room.
9. Conduct a vote so that the class can select the applicant who seems to be best qualified for the job vacancy.
10. Have the applicants return to the room. Advise them as to who was chosen for the job. (You might role-play the induction phase.)
11. Students are to answer questions in the Laboratory Manual.

Homework

If optional Assignment 74 is used, review Readings 5, 6, 7, 8, 23, 24, 27, and 35. Have students bring textbooks to class for discussion. If the optional Assignment 74 is omitted, there is no homework.

Answers for Laboratory Manual

1. Recruit a new worker.
2. Yes.
3. Yes.
4. Answers will vary.
5. Testing, references, physical examinations.

ASSIGNMENT 74 (OPTIONAL)

Review No. 4

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

Given the summaries of Readings 5, 6, 7, 8, 23, 24, 27, and 35, ask and answer questions about identifying consumer demands, product development, planning production, designing the plant, supplying equipment and materials, and personnel technology.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to use one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking and discussion.
3. Have each group of students meet briefly and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker who is knowledgeable about manufacturing to talk to the class. Schedule the speaker for the first class period and tape record his talk, so it can be played to your other classes.
5. Schedule a field trip to a small manufacturing plant where students can observe the complete manufacturing operation.

Homework

None

ASSIGNMENT 75

Test No. 4

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 4, select responses from a list of items related to concepts presented in Readings 5, 6, 7, 8, 23, 24, 27, and 35.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Distribute answer sheets and fill out needed information.
4. Pass out test booklets. Caution students to keep them closed until you say "begin."
5. Read the directions for filling in answer blanks. Then direct students to open test booklets and begin.
6. Allow 35 minutes for completion. Collect answer sheets first; then test booklets, pencils, erasers, and eraser shields.
7. Review the test with students to provide feedback.

Homework

Reading 34, *Manufacturing Personnel Technology*

Answers to Test No. 4

1. B	2. A	3. C	4. C	5. C	6. D	7. C	8. C	9. B
10. A	11. C	12. D	13. A	14. A	15. D	16. D	17. C	18. D
19. C	20. C	21. A	22. B	23. B	24. C	25. D	26. B	27. D
28. C	29. B	30. B	31. A	32. C	33. B	34. B	35. C	

ASSIGNMENT 76, ACTIVITY 41
READING 34

Manufacturing Personnel Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about manufacturing personnel technology:
   a. Determine how a worker should be selected for a job when there are several qualified applicants for the job.
   b. List the rules (regulations) under which your father works at his job and compare them with the rules in your school.

Discussion

2. Given a presentation on manufacturing personnel technology:
   a. Name the three technologies of manufacturing.
   b. Name five basic kinds of personnel practices in manufacturing firms and one subdivision of each kind.

Laboratory Activity

3. Given 12 pictures, name the basic kind of *personnel practice* and the subdivision or specific practice shown in each one.

Time Schedule

5 Overview
15 Presentation
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 set Transparencies:
- 76-1. Structural Elements in Manufacturing Technologies
- 76-2. Personnel Practices of Manufacturing Technologies
- 76-3. Recruiting
- 76-4. On-the Job Training
- 76-5. Economic Rewards
- 76-6. Promoting
- 76-7. Retiring

Overview (5)

The lesson today concerns manufacturing personnel technology.

1. The reading named five basic kinds of personnel practices: *hiring, training, working, advancing, and retiring.*
2. I will explain how these personnel practices relate to the management, production, and personnel concept.

Presentation (15)

1. It is *impossible to separate completely* the jobs of management, production, and personnel.

a. For example, most *production workers are managers* to some extent. When a machine operator on a production job measures and checks his work against the plan, he is performing a control function, although control is listed as a function of management.
b. As another example, *production design is a management job*; yet the product designer produces something concrete and useful as he develops the prototype of a new product.
c. The *difference* between production workers and managers is based upon the *amount of time spent* on management tasks.
d. Personnel practices *affect both* management and production workers in many ways.

2. Show Transparency 76-1, *Structural Elements in Manufacturing Technology*. Here are the three kinds of technology within manufacturing:
   a. Management *plans* and *organizes* the inputs to the system, and *controls* the plan and organization in order to produce products.
   b. Production workers actually *produce* the product. Some production workers do have management responsibilities, but they do not spend great amounts of time in managing.
   c. Throughout the manufacturing system, the employee remains the most important factor. Manufacturing personnel technology includes all the practices that *affect the behavior of employees*, both the production workers and the managerial employees.
3. Employees must work efficiently. The jobs of the workers must be planned, organized, and controlled — just as the equipment and materials in the system must be planned, organized, and controlled. This helps the company to operate efficiently, so that it will make a profit.
4. Personnel are the most valuable resource of manufacturing. Most other resources become worn or used up, and must be replaced regularly. People are a useful resource for many years.
5. Show Transparency 76-2, *Personnel Practices of Manufacturing Technology*. There are five kinds of personnel practices: hiring, training, working, advancing, and retiring.
   a. These practices are carried out in all kinds of manufacturing firms. They are the same as the personnel practices for construction employees.
   b. The details (the specific technology) may differ according to the kind of workers, the local customs, the products, and in-plant or on-site differences.
6. Show Transparency 76-3, *Recruiting*. Ask students what Bill is attempting to do. (Recruit.) What is recruiting? (Getting people to apply for a job.)
7. Show Transparency 76-4, *On-the-Job Training*. Training practices provide the manager or production worker with some *knowledge or skill* that he needs to perform his job well or to advance.
8. Show Transparency 76-5, *Economic Rewards*, and ask students to explain the term *economic reward*. (Money paid for work.) Working practices deal with *economic rewards*, the *physical* setting, and the *social* environment that have a direct influence on employees' behavior.
9. Show Transparency 76-6, *Promoting*. Advancement practices may include demoting or discharging, in addition to promoting.
10. Show Transparency 76-7, *Retiring*. Retirement practices concern what happens to an employee when his *working life* is completed.
    a. Many companies have a plan that provides a *monthly income* for retired workers, based on how long they work for the company.
    b. Company counselors may help employees to plan ahead for retirement.
    c. The company may recognize an employee's *service and loyalty* through a gift or a company dinner when he retires.
    d. There may be other so-called "fringe" benefits.

Laboratory Activity (25)

Today each group of students will be asked to identify personnel practices that are represented by illustrations in the Laboratory Manual. After each group has identified the illustrations, their decisions will be eval-

uated to determine who are the best personnel managers.

1. Students are to work in groups of five, and their answers are to come from the group's decision.
2. Each picture (Figs. 41-1 to 41-12) in the Laboratory Manual requires two answers. Answer "A" should be a main kind of personnel practice while answer "B" should be a subdivision of that practice.
3. Figure 41-13 in the Laboratory Manual is a list of the possible answers.
4. After groups have finished identifying pictures, have group recorders exchange Laboratory Manuals for evaluation.
5. Group foremen can check answers while the teacher reads the correct answers from the Teacher's Guide.
6. Have group foremen complete the tally sheet, Fig. 41-14, and return the Laboratory Manuals to the proper groups.
7. Ask each group foreman to report the score for his group. Record this score on the board and determine the group with the highest score. This group knows the most about personnel technology and would make very efficient personnel managers.

Answers for Laboratory Manual

1.	(A) Hiring	(B) Recruiting
2.	(A) Working	(B) Economic rewards
3.	(A) Retiring	(B) Recognizing service
4.	(A) Hiring	(B) Selecting
5.	(A) Working	(B) Social environment
6.	(A) Retiring	(B) Counseling
7.	(A) Hiring	(B) Inducting
8.	(A) Training	(B) On-the-job
9.	(A) Working	(B) Physical setting
10.	(A) Training	(B) Other training (classroom or seminar)
11.	(A) Advancing	(B) Promoting
12.	(A) Retiring	(B) Awarding fringe benefits

Homework

None

ASSIGNMENT 77
ACTIVITY 42A-C

Manufacturing Production Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given a completed Process Flowchart and an assigned production activity, begin manufacturing of a required number of products.

Time Schedule

5 Overview
40 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

As needed

1	Production Flowchart
All	job description sheets
All	quality control devices
All	working drawings
All	operation sheets

Supplies (Per student)

As needed

Overview (5)

Today you are going to begin manufacturing our selected product. You will have three full days to produce the product.

1. Each member of the production team must perform his job efficiently if the production schedule is to be met.
2. However, all safety precautions must be followed. An injured worker cannot take part in production activities, so be careful when you handle tools and materials.

Laboratory Activity (40)

1. *Display* and *review* the Production Flowchart.
2. Direct students to their assigned work stations and have them review the job

3. After reviewing the job description sheet, students may begin production. The teacher should look for "bottlenecks" and attempt to alleviate them.
4. Be sure that students follow safety precautions.
5. Plan for the storage of products as they are produced.

Safety Precautions

1. Wear safety glasses if you are operating machines.
2. Keep fingers away from cutting edges.
3. Do not disturb students who are operating machines.

Homework

Reading 37, *Organized Labor and Collective Bargaining*

Note

The teacher should make note of any production procedures that he believes should be changed on the following day. These written notes can then be discussed in the Overview the following day. The teacher should also note whether some students will complete one production operation and need reassignment for the following day's activity.

ASSIGNMENT 78, ACTIVITY 43
READING 37

Organized Labor and Collective Bargaining

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about organized labor and collective bargaining:
   a. List reasons why strikes and long disputes happen between labor and management.
   b. Explain what is meant by collective bargaining, and list three factors that may be involved in bargaining.

Discussion

2. Given a presentation on collective bargaining:
   a. Name two steps taken before striking in an attempt to solve a labor-management problem.
   b. Name four reasons for labor-management arbitration.

Laboratory Activity

3. Given a collective bargaining situation, arrive at a solution by following the appropriate procedure.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Overview (5)

1. You have read about the history of organized labor and the collective bargaining procedure.
2. I will tell you about the main reasons why labor-management friction occurs, and introduce the steps followed in trying to solve a labor-management problem.
   description sheets previously prepared.
3. We will discuss two steps taken by management before striking and four reasons for labor-management friction.

148

4. The laboratory activity will describe a labor-management dispute which you must solve by collective bargaining procedures.

Presentation (10)

1. The main reasons for labor-management friction are economic.
   a. The employer wants to make as much profit as he can or hold costs down. Employees would like to increase their wages and improve their working conditions.
   b. Another major conflict involves work rules. In any organization there must be rules. Conflict occurs between those who make the rules and those who will enforce them.
   c. Amount of wages. Workers are usually seeking higher wages to keep up with the increase in the cost of living.
   d. Working conditions. Leadership, safety considerations, and other conditions under which individuals must work are morale factors.
   e. Fringe benefits. Sick leave, paid holidays, recreation facilities, and paid hospitalization are a few of the fringe benefits wanted by workers.
2. In general, five steps are followed in trying to solve a labor-management problem:
   a. Union proposal (union demands).
   b. Company counter proposals (company offer.)
   c. Negotiation (give-and-take between parties).
   d. Mediation/conciliation (a third party tries to bring the matter to settlement satisfactory to the other two parties).
   e. Strike (work stoppage—negotiations, mediation continue).
3. Each step is used, *in order*, only after the preceding one fails to solve the problem.

Discussion (5)

The students are about to begin a role-playing activity involving a labor-management problem. The following discussion will reinforce points in the presentation which will be helpful in the laboratory activity.

1. Name and explain two steps that are taken *before* striking in an attempt to solve a labor-management problem. (Negotiation, mediation.) (Bring to students' attention that strikes are not a solution to a problem, but only one way of working toward a solution. Strikes result in hardship in many cases, for example, loss of income to both parties and in public inconvenience.)
2. Name four reasons for labor-management friction. (Work rules, amount of wages, working conditions, fringe benefits.)

Laboratory Activity (25)

1. Assign the members of each regular group one of the following job titles:
   a. Local union president.
   b. Local union vice president.
   c. Company industrial relations director.
   d. Plant manager.
   e. Federal mediator.
2. Review the "Situation" in the Laboratory Manual with the students to be sure they understand it. Then give them 15 minutes to arrive at one of the solutions.
3. During the last 10 minutes of the period, have the federal mediator for each group report on his group's solution and briefly describe how the solution was arrived at.

Homework

None

ASSIGNMENT 79, 81
ACTIVITY 42A-C

Manufacturing Production Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

Given a completed production system, continue to manufacture products.

Time Schedule

5 Overview
40 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

As needed

Supplies (Per student)

As needed

Overview (5)

Today you will continue manufacturing products.

Note

The teacher may wish to mention problems or changes in procedure as a result of the first day's production activity.

Laboratory Activity (40)

1. Discuss with the class where they are in production processing at the present time.
2. If certain components or subassemblies have been completed in the first day's activity, students will require new work assignments. Review these new work assignments, making sure that the new workers read the Job Description Sheet related to their job before they begin.

Assignment Schedule for Next Four Days

Assignment	Activity	Title
79	42A-C	Manufacturing Production Technology (Continue production.)
80	44	Working, Advancing, and Retiring
81	42A-C	Manufacturing Production Technology (End production.)
82	45	Establishing Accident Prevention Programs

Homework

Assignment 79: Reading 36, *Working, Advancing, and Retiring*

Assignment 81: Reading 29, *Establishing Accident Prevention Programs*

Note

Look ahead to Assignment 83 to build a Hero's engine.

ASSIGNMENT 80, ACTIVITY 44
READING 36

Working, Advancing, and Retiring

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading about working, advancing, and retiring:
   a. Discuss why *sweatshop* conditions are no longer present in industry today.
   b. Explain why rest periods and coffee-breaks make workers more effective on their jobs.

Discussion

2. Given questions:
   a. State the original purpose of a work area in the manufacturing industry.
   b. Name some desirable working conditions in the manufacturing industry.

Laboratory Activity

3. Given a *labor-management problem,* solve it through discussion between management and union representatives.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Overview (5)

1. You read about some of the considerations that must be given to working, advancing, and retiring.
2. I will tell you about the original purpose for which work areas were designed, and about improved working conditions today.
3. You will be asked to state the original purpose of a work area, and name some desirable working conditions.
4. In the laboratory activity you will represent *either management or a union* in reaching an agreement on a working condition that has created a problem.

Presentation (10)

Today I will tell you something about historic working conditions within manufacturing plants.

1. *The original purpose of a work area was to produce goods;* a building and machines were all that most factory owners provided. These men did not consider whether working conditions were safe and pleasant for their employees.
2. Today, *good working conditions* include many things:
   a. Enough light
   b. Proper ventilation
   c. Sanitary facilities
   d. Air conditioning
   e. Acoustic control
   f. Dust removal
   g. Rest periods
   h. Cheerful lunchrooms
   i. Grievance boards
   j. Plant newspapers
   k. Adequate wages
   l. Vacation pay
   m. Insurance benefits
   n. Sick pay
   o. Recreation facilities

Discussion (5)

The students are about to begin a role-playing activity involving a problem of working conditions in a plant. This discussion will reinforce points from the presentation which will be applied in the laboratory activity.

1. What was the original purpose of a work area? (To produce goods, with little regard for the employee or his benefits.)
2. Name some desirable working conditions which contribute to safety in a manufacturing plant. (Lighting, ventilation, sanitation, acoustics, dust removal, rest periods, etc.)

Laboratory Activity (25)

Today the students will play the roles of labor and management in settling a dispute over working conditions and salaries.

1. Assign the following titles to the individuals in each group:
   a. Worker. (Two needed per group.)
   b. Management representatives. (Two needed per group.)
   c. Union steward. (One needed per group.)
   d. Recorder. (One needed per group.)

2. Review *labor's position.* (Workers and the union steward will argue these points.) A group of workers from the J-H Manufacturing Corporation have gathered together to formulate a complaint to their union steward. The complaint is based upon the following:
   a. *Workers complain that toxic fumes are present in the area* where parts are being fabricated.
   b. Although *respirator and exhaust fans are present,* the workers state that the *fumes are still irritating,* and they are requesting *10-minute breaks* every hour.
3. Review *management's position.* (Management representatives will argue these points.)
   a. The management of J-H Manufacturing Corporation states that although the *fumes* are present, they are a *usual part of the manufacturing process.*
   b. Management further states that with the exhaust and respirator devices present, the *concentration of fumes is low enough* so it will not bother the workers.
   c. Management also states that *production flow* would be *severely hindered or stopped* if the workers were given a 10-minute break every hour.
   d. Management will hire a worker to relieve other workers so they may take 10-minute breaks.
4. Review the following general information:
   Present working schedule:
   Starting time: 8 a.m.
   Morning Break: 10 to 10:10 a.m.
   Lunch Break: Noon to 12:30 p.m.
   Afternoon Break: 2 to 2:15 p.m.
   Quitting time: 4:30 p.m.
5. Instruct students to *negotiate.* During this meeting labor and management must decide on a *compromise* to stop a possible walkout. They must attempt to negotiate a settlement acceptable to both parties.
6. Give the students approximately *10 minutes to reach a decision.* Use the *last 10 minutes* of the period to have the *union steward for each group present his group's decision to the class,* along with the *reasons* for reaching the decision.

Homework

None

ASSIGNMENT 82, ACTIVITY 45
READING 29

Establishing Accident Prevention Programs

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to establishing accident prevention programs:
   a. Give reasons why a large company would be more interested in promoting occupational health and safety programs for its workers than a small company.
   b. Explain why it is easier to plan *accident controls* for machines than it is for people.

Discussion

2. Given a list of five unsafe working conditions, list appropriate protective equipment to protect the worker from these unsafe conditions.

Laboratory Activity

3. Given a checklist of 28 items relating to safety in a school laboratory:
   a. Inspect the industrial arts laboratory and show on the checklist whether or not their school laboratory provides for the listed items.
   b. Suggest *corrective action* to maintain safe working conditions.
4. Given a list of unsafe conditions and devices to protect workers against the conditions, match each unsafe condition with a suitable protective device.
5. Given nine photographs showing unsafe working conditions:
   a. Identify the unsafe conditions.
   b. State the corrected conditions.

Time Schedule

5 Overview
5 Presentation
10 Discussion
25 Laboratory Activity

Overview (5)

1. Today's textbook reading describes the history of occupational health and safety, and current programs of accident prevention in manufacturing industries.
2. I will tell you about three kinds of *solutions to accident prevention problems* in industry.
3. During the discussion, you will have the opportunity to identify equipment used to *protect against safety hazards* in industry.
4. In today's activity you will be given the opportunity to *evaluate safety* in your industrial arts laboratory, using an accident prevention checklist.

Presentation (5)

There are three kinds of solutions to the problems usually met in applying accident prevention to the operation of a plant.

1. Safety equipment is provided and *safe job procedures* are planned. Safety equipment includes safety glasses, hard hats, respirators, aprons, gloves, and shoes.
2. A *regular inspection system* is used to find and correct anything that departs from the planned safety procedures. Examples might be improper use of equipment, worn or defective equipment, and poor safety habits of employees.
3. Causes of accidents are investigated so that *corrective action* can be taken to prevent a recurrence.

Discussion (10)

The students are about to begin evaluating the industrial arts laboratory, using an accident prevention checklist. This discussion should reinforce points developed in the presentation which will be applied in the laboratory activity.

Examples:

Hazards	Protective Equipment
1. Overhead hazards	Hard hats
2. Eye and face dangers	Face shields or safety glasses
3. Dust, toxic fumes, chemicals	Respirators
4. Hot liquids	Aprons, gloves, boots
5. Handling heavy objects	Safety shoes

Some safety hazards cannot be removed from a manufacturing plant. However, their *danger* to workers can be *minimized* by using protective devices.

Have students suggest several *safety hazards* which cannot be removed without disrupting production flow. Also have the students suggest protective equipment which can protect employees from injury.

Laboratory Activity (25)

Today the students will *evaluate their laboratory* using an accident prevention checklist.

1. Students will work in groups of five.
2. Each group's safety supervisor will be a "safety superintendent."
3. Make sure the groups *spread out* through the laboratory and evaluate all the facilities.
4. Remind the students to *work individually* on the checklist. They will report their individual evaluation later to the safety superintendent when they meet together.
5. Have the students rate the laboratory conditions as good, fair, or poor.
6. Have each safety superintendent collect the reports from his group, summarize them according to instructions in the Laboratory Manual, and report results to you.
7. The other students will do Problems 2 and 3.
8. Lead a discussion of reported hazards. Ask for suggestions from the students concerning corrective measures.

Homework

Reading 40, *Harnessing Energy from Nature*

Answers for Laboratory Manual

1. f
2. c
3. b
4. h
5. g
6. e
7. d
8. a

Note

Look ahead to Assignment 84 and gather materials for a demonstration on extracting.

ASSIGNMENT 83, ACTIVITY 46A
READING 40

Harnessing Energy from Nature

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given situations related to harnessing energy from nature:
   a. Explain how *wind* energy can be *converted* into electrical energy.
   b. Discuss the possibility of the United States generating *too much* electrical energy.

Discussion

2. Given the term "energy":
   a. State a simple definition for it.
   b. List the six general classes of nature's energy.
   c. Give an example for each class.
3. Given one form of nature's energy, state a way for doing each of the following:
   a. Collecting it.
   b. Containing it.
   c. Controlling it.

Laboratory Activity

Given the equipment and instructions, build a simple engine.

Time Schedule

5 Overview
10 Demonstration
10 Discussion
20 Laboratory Activity

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedures they will follow.

Equipment

1 working model of steam engine
1 propane torch
1 overhead projector w/screen

Supplies

1 set Transparencies:
83-1. *Forms of Natural Energy*
83-2. *Wind*
83-3. *Water at Work*
83-4. *Harnessing the Tides*
83-5. *LASER Beam*
83-6. *Nuclear Energy*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1	scratch awl
1	#40 twist drill
1	hand drill
1 pr.	diagonal cutting pliers
1	hacksaw with fine blade
1	rule
1	V-block
4 pr.	safety glasses
1	spark lighter

Supplies (Group of 5)

1	coat hanger
1	pipe cleaner
1 kit	epoxy glue (2 tubes)
1	size 12 snap swivel (fishing tackle)
1 pc.	3/32″ O.D. aluminum *or* brass tubing, 2½″ long (model plane gas line)
1	35-mm. film can with lid
¼ sht.	fine emery cloth
	water
2 pcs.	¾″ thick scrap wood (about 1″ x 2″)
2 pcs.	⅜″ dia. x 2″ dowel

Overview (5)

Today you will start on a new activity; it concerns harnessing energy from nature.

1. The text explained that harnessing nature's energy enables man to harvest and refine materials, transport them, and process them into products. Energy is one of the inputs to the manufacturing production system.
2. I will show you some transparencies and discuss the six major classes of nature's energy. I will demonstrate how to change chemical energy to mechanical energy.
3. You will be asked to define energy, tell how energy can be harnessed, and name some factors to be considered in harnessing energy.
4. For the next two days in your laboratory activity, you will harness heat energy by building a steam engine.

Demonstration (10)

Today the teacher will demonstrate the operation of a small steam engine based on one designed by Hero of Alexandria about 150 B. C.

1. Steam engines convert energy from one form to another, so that it can be used to do work.
2. Chemical energy, in the form of fuel, is converted to heat energy by burning the fuel. (Demonstrate by burning paper, matchsticks, candle, alcohol, etc.)
3. If the heat energy is used to heat water to its boiling point, and some of the water turns into steam, the steam can be harnessed to do work. (Demonstrate how to light, adjust, and extinguish the torch. Demonstrate how the model works by applying heat to the engine. Show the class what they will be working to accomplish. See Fig. 46A-1 in the Laboratory Manual.)

Discussion (10)

The purpose of this discussion is to develop concepts leading to an understanding of the term "energy," and the six classes in which it is found. Considerations by industry in selecting a form of energy are to be presented.

1. State a simple definition of *energy*. (The ability or *capacity to do work.*)
2. Can one create or destroy energy? (No. Energy can only be changed from one form to another.)
3. How does man benefit from nature's energy? (He harnesses it by collecting, containing, and controlling it.)
4. What considerations does industry make in selecting a form of energy to harness? (Cost, efficiency, and availability.) (NOTE: the teacher may list responses for Question 4 on the chalkboard for use in developing Question 5.)
5. What are the six classes of nature's energy? (*Mechanical, heat, electromagnetic, chemical, radiant,* and *nuclear.*)
6. The transparencies that I will show you illustrate where energy exists in nature. We will discuss some ways man uses nature's energy.

Transparency 83-1, *Forms of Natural Energy.*

1. Wind
2. Running water
3. Ocean tides
4. Sun's radiant energy
5. Energy released by radioactive decay of some elements.

Transparency 83-2, *Wind.* Air moving over the earth is called "wind." The *movement* is mechanical energy. A windmill collects this energy and concentrates it to pump water, grind grain, or drive a generator.

Transparency 83-3, *Water at Work.* A waterwheel and a modern turbine are both ways of collecting mechanical energy from moving water. The turbine may drive a generator, which *converts* the mechanical energy into electrical energy. (Ask the students for suggestions as to how turbines and generators have changed man's way of living.)

Transparency 83-4, *Harnessing the Tides.* Ocean tides can be harnessed. Machinery for harnessing tidal energy has been built across the Rance River in northern France. It will serve to harness tidal power in the English Channel where tides sometimes rise and fall as much as 44′.

Transparency 83-5, *LASER Beam.* The illustration shows a coherent laser beam. The sun's light is incoherent. (Beams travel in all directions.) The laser device generates a giant pulse of parallel light rays which bursts out of the machine as a coherent laser beam.

Transparency 83-6, *Nuclear Energy.* Nuclear energy is widely used in supplying the power to run large ships, especially in the military. The illustration shows a nuclear submarine. (A civilian ship which runs on nuclear energy is the *Savannah.* See how many other ships the class can name which are driven by nuclear energy.)

Laboratory Activity (20)

The laboratory activity is designed to focus attention on uses of energy and the *conversion* of one type of energy to another. Students will harness steam in such a way that the converted energy *could* do work. (The engine is not actually coupled to any practical tool in this experiment.)

1. Divide the class into groups of five. Have the group foremen subdivide the work tasks.
2. Distribute equipment and supplies.

3. Assign each group to a vise and work area.
4. Instruct the students on laying out, drilling, bending, and gluing. See Figs. 46A-1, 46A-2, 46A-3 in the Laboratory Manual.
5. Students are to store the engines carefully for testing in ACTIVITY 46B.

Homework

Reading 39, *Extracting Raw Materials*

ASSIGNMENT 84, ACTIVITY 46B
READING. 39

Extracting Raw Materials

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information related to the extracting of raw materials:
   a. List the *mineral resources* of your state.
   b. Discuss what might happen if man uses up the earth's supply of nonreproducible mineral resources.
2. Given the necessary equipment and supplies, demonstrate the conversion of fuel to heat energy, and of heat energy to mechanical energy, by operating a steam engine.

Time Schedule

5 Overview
20 Presentation - Demonstration
20 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

Equipment

1 5 qt. plastic bucket
1 pc. 3/8″ dia., 24″ length, polyethylene tubing
1 pc. 3/8″ dia., 18″ length, dowel rod (sharpened)
1 large tin can (32 oz. or more)
1 pc. 3/8″ dia., 36″ length, polyethylene tubing

Supplies

1 corrugated cardboard disc
1 #10 tin can *or* bucket
1 bucket moist sand
3 pcs. common brick

Supplies (Per teacher)

1 cutout kit, *Gas Serves Your Community*, for display only

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 steam engine from ACTIVITY 36A
1 bench vise
1 propane torch
1 pr. slip-joint pliers
1 spark lighter

Supplies (Group of 5)

water
1 part of coat hanger (10″ straight piece)
1 kit epoxy glue (two tubes)
5 pr. safety glasses

Overview (5)

1. In today's reading you learned that there are three classes of mineral resources:
   a. Mineral fuels.
   b. Nonmetallic minerals.
   c. Metallic minerals.

   All materials which men use in manufacturing processes, except those harvested or slaughtered, are included in these three groups.
2. In today's demonstration you will learn

that minerals are extracted from the surface of the earth, from below the surface, from the atmosphere, and from the earth's waters. Display *Gas Serves Your Community*.

3. In your laboratory activity you will run your steam engine and use the heat energy from burning fuel converted to steam pressure.

Presentation - Demonstration (20)

Today's lesson concerns extracting raw materials from nature.

1. All materials that are extracted are of the nonreproducible type. For example, a coal mine will not grow or produce new coal. Coal may be taken from a mine, but the coal mine will never replenish itself.
2. We extract from the surface of the earth, within the earth, above the earth (in the atmosphere), and from the earth's waters. The following demonstration will show you how raw materials in a liquid or gas form are extracted. Gas, oil, and water are extracted by drilling and pumping.
3. Set up the materials as shown in Fig. 84-1. Do not insert drill yet.
4. Using the sharpened dowel as a drill, rotate it between your hands to sink two shafts down through the sand and cardboard into the underground deposit. Wiggle your drill around to make sure the shaft hole is big enough. See Fig. 84-1.
5. Remove the drill. Insert polyethylene tubing as a casing into both shafts, down to the deposit.
6. Place the bucket near the edge of the table so that the end of the longer piece of tubing will be below the bottom of the bucket. Place the tin can under the end of the tubing. See Fig. 84-2.
7. Imitate the pressure naturally found in an oil deposit by blowing into the short tube until water flows out of the long one.

Laboratory Activity (20)

The purpose of this laboratory activity is to permit students to run their steam engines (made in ACTIVITY 46A) and see the heat energy from burning fuel converted to steam pressure, a kind of mechanical energy which can be controlled so that it will do work.

1. Students are to work in the same groups of five as in ACTIVITY 46A.
2. Distribute an epoxy glue kit (for repairs, etc.), a propane torch, sections of coat-hanger wire, and the devices they constructed in ACTIVITY 46A.
3. Warn your students (a) that the engine will explode if the openings are clogged and (b) that safety glasses must be worn: water which sprays out occasionally could burn a student's eyes.
4. Supervise use of the torch.

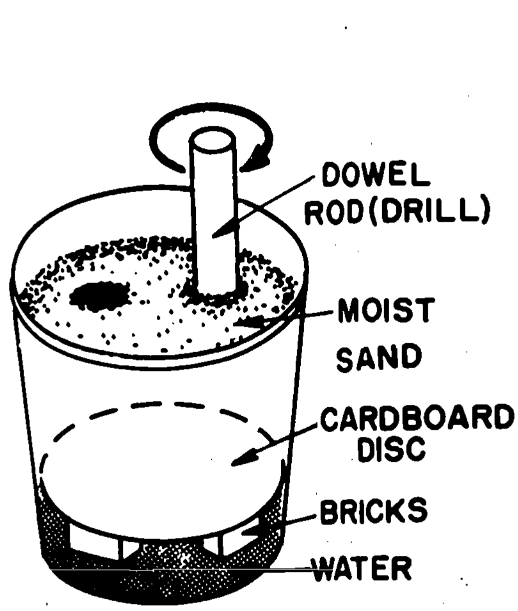


Fig. 84-1. Material Setup for Demonstration

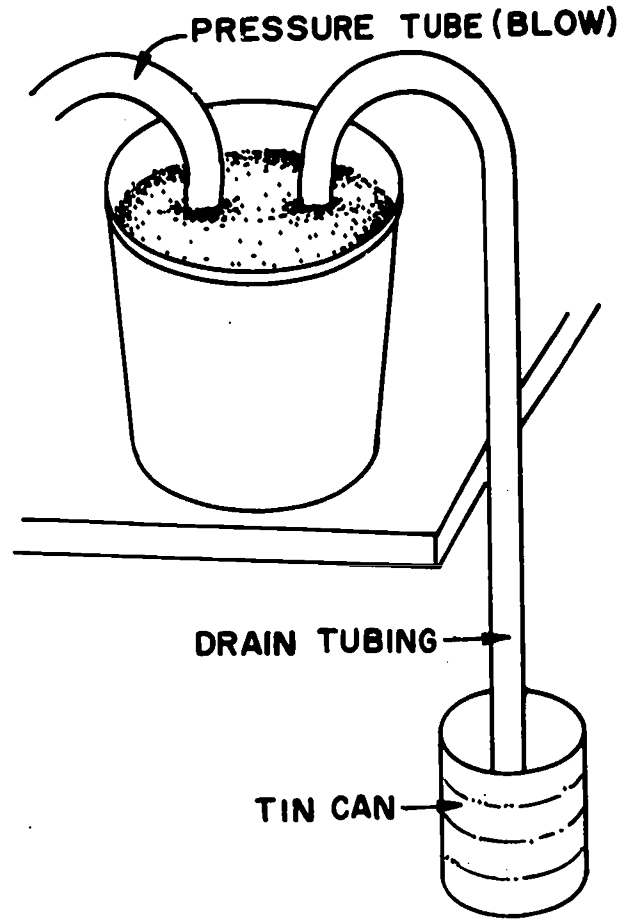


Fig. 84-2. Pumping Setup

5. Instruct students to vary the amount of heat applied to the "engine," and note any change in speed of the engine.
6. Allow time for students to answer the questions in the Laboratory Manual.
7. Check student's work in the Laboratory Manual.

Safety Precautions

1. Wear safety glasses to protect your eyes from boiling water.

Homework

Reading 38, *Securing Reproducible Raw Materials*

2. Do not heat engine without water in it.
3. Take care when lighting and extinguishing torch.

ASSIGNMENT 85, ACTIVITY 47
READING 38

Securing Reproducible Raw Materials

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a reading about securing reproducible raw materials:
   a. Explain why *conservation* is important in the *harvesting* of reproducible raw materials.
   b. Discuss the effects of air and water pollution on marine life.
   c. Determine if *marine* life will become a major source of human food as the world's population continues to grow.

Discussion

2. Given the names of 10 raw materials, classify six as reproducible raw materials and the other four as nonreproducible raw materials.

Laboratory Activity

3. Given a set of 11 illustrations, identify for each one:
   a. The practice shown.
   b. The raw material secured.
   c. The tools and equipment used.
   d. A product in which the material is used.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Overview (5)

1. Today's reading concerned reproducible raw materials: what they are and how they are secured.
2. I will explain further the chief kinds of reproducible raw materials, how they differ from other raw materials, some practices used in securing them, and the need for conserving parent or seed stock.
3. You will be asked to classify 10 raw ma-

terials as either reproducible or nonreproducible.

4. In the laboratory activity, you will look at photographs showing ways in which reproducible raw materials are secured. You will be asked to name the practices, the raw materials, the tools and equipment, and the products being secured.

Presentation (10)

1. *Reproducible raw materials* either are living things or come from living things. They may be plants, wild or domestic animals, fish, or even bacteria (for drugs).

2. The *difference* between reproducible raw materials and other raw materials is that *living things reproduce their own kind,* but all other *raw materials are gone,* once they are secured from nature. You will read about nonreproducible resources in another lesson.

3. *Securing* is a broad term applied to ways of obtaining reproducible raw materials. It includes *harvesting* crops, *slaughtering* domestic meat animals, *milking* cattle, *gathering* eggs, *seining* fish, and *netting* shrimp and crabs.

4. A plant may or may not be destroyed when a reproducible raw material is secured from it.

   a. Fruits, such as apples or pears, are picked every year from the same trees.
   b. Some trees can be "tapped" every year to withdraw sap. If this is done properly, the tree is not harmed.
   c. The plants that bear tomatoes, squash, cereal grains, cotton, and many other crops are called "annual" plants because they die at the end of the harvest season. Sometimes the machines that gather the wanted part destroy the whole plant.
   d. A tree must grow for many years before it is large enough to provide lumber and paper, but after the trunk is cut off the roots usually do not produce another large tree.
   e. All plants are called "reproducible" because each kind or species reproduces more like itself.

5. Securing raw materials of animal origin may or may not require killing the animal.

   a. Milk, wool, and honey are examples of materials taken without harm to the animals that produced them.
   b. All meat, poultry, and seafood must be secured by taking the life of an animal.

6. *Conservation* concerns all living things and the environment in which they live.
   a. To conserve animals, there must always be *parent stock* left alive to reproduce. If, for example, all the mature salmon are seined from a river, there will be no eggs laid to produce a future harvest.

   b. To *conserve* a forest environment or *habitat,* mature trees must be cut and removed carefully so as not to kill large numbers of young trees in the same forest. Otherwise, animals that depend on the trees for food or shelter will die.

   c. *Polluting* the water of lakes, rivers, or oceans kills some or all of the plant and animal life in the water, and the effects of pollution last for years. Factory wastes, oil, and some kinds of detergents have in the past destroyed reproducible resources and natural environments worth many millions of dollars.

   d. Most cultivated crops grow in *topsoils* and cannot grow in the heavy clay or rock that lies under it. Nature formed this topsoil over long periods of time. Preventing the erosion (washing away) of topsoil is a vital part of conserving our reproducible raw materials.

   e. *Controlling diseases* of plants and animals and preventing fires are other conservation practices.

Discussion (5)

1. (List the following 10 raw materials on the chalkboard and have students classify them in one of two groups: reproducible or nonreproducible.)

Raw Materials	Reproducible	Non-reproducible
1. Corn	x	
2. Eggs	x	
3. Petroleum		x
4. Iron ore		x
5. Hogs	x	
6. Peanuts	x	
7. Clay		x
8. Peaches	x	
9. Tuna fish	x	
10. Natural gas		x

2. Which of the reproducible materials normally is secured without harm to the individual plant or animal that produced it? (Eggs and peaches.)

Laboratory Activity (25)

Today's activity will help the student to recognize how different reproducible raw materials are secured.

1. Students are to follow the directions in the Laboratory Manual.
2. Approximately 10 minutes before the end of the period, review with your students the correct or appropriate information for each picture in the Laboratory Manual.
3. Supervise any needed cleanup.

Homework

Reading 41, *Manufacturing Production Technology*

Answers for Laboratory Manual

(Numbers correspond with Figure numbers.)

1. Practice: tapping and collecting (gathering)
   Raw Material: natural rubber (latex)
   Tools or Equipment: knife, cup, and bucket
   Products: tires, boots, belts, hoses, tape, gloves, hot water bottles, raincoats, baby pants, foam, toys, etc.
2. Practice: milking
   Raw Material: unpasteurized milk
   Tools or Equipment: milker
   Products: milk, butter, cheese, ice cream, casein glue, etc.
3. Practice: shearing
   Raw Material: wool
   Tools or Equipment: a pair of shears
   Products: clothing, cloth, yarn, etc.
4. Practice: combining (harvesting and threshing with one machine)
   Raw Material: grain
   Tools or Equipment: combine
   Products: cereal, flour, animal feed, etc.
5. Practice: cutting
   Raw Material: trees
   Tools or Equipment: chain saw
   Products: lumber, plywood, paper, chemicals, garden mulch, wooden furniture, etc.
6. Practice: stripping
   Raw Material: cotton
   Tools or Equipment: mechanical cotton stripper
   Products: clothing, cloth, yarn, etc.
7. Practice: seining
   Raw Material: fish (salmon)
   Tools or Equipment: boat, purse seine, brail (dip net)
   Products: food, fertilizer, glue, oil, etc.
8. Practice: cutting
   Raw Material: jute
   Tools or Equipment: large knives
   Products: burlap, rope, blended cloth, etc.
9. Practice: cutting
   Raw Material: tobacco
   Tools or Equipment: large knife
   Products: pipe and cigar tobacco
10. Practice: netting
    Raw Material: shrimp
    Tools or Equipment: nets, boats
    Products: shrimp, shrimp products
11. Practice: tapping and collecting
    Raw Materials: maple sap
    Tools or Equipment: tap, bucket
    Products: sugar, maple syrup, other sugar-related products

ASSIGNMENT 86, ACTIVITY 48
READING 41

Manufacturing Production Technology

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about manufacturing production technology:
   a. Explain how production practices add value to raw materials.
   b. List ways in which technology has made work in your home easier to do.

Laboratory Activity

2. Given pictures illustrating the five main production stages in making a newspaper, name practices that students think might be used at each stage.

Time Schedule

5 Overview
15 Presentation
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment

1 overhead projector/screen

Supplies

1 set Transparencies:
- 86-1. *Stage 1. Preparing Raw Materials*
- 86-2. *Stage 2. Making Industrial Materials*
- 86-3. *Stage 3. Making Components*
- 86-4. *Stage 4. Combining Components*
- 86-5. *Stage 5. Preparing for Distribution*

Overview (5)

Beginning today you will be involved in a series of activities that concern manufacturing production technology.

1. In your reading, you learned about *five production stages* and some kinds of production processes.
2. I will explain how production practices are classified as preprocessing, processing, or postprocessing.
3. In your laboratory activity, you will play a game by trying to identify or imagine several practices used in each of the five stages of producing a newspaper.

Presentation (15)

The production of goods can be divided into five stages. No matter which stage we are discussing, there are three kinds of production practices.

1. *Preprocessing practices* are activities that concern materials, but do not change the forms of the materials.
   a. *Receiving* a material involves unloading it from a truck or other vehicle and checking it in.
   b. *Unpacking* a material means taking it out of whatever sort of box or crate it was shipped in.
   c. *Handling* a material means physically moving it.
   d. *Storing* a material means holding or keeping it in a regular place until it is needed.
   e. *Protecting* a material may involve covering it, keeping it cool, guarding it, or any other practice that prevents loss or damage.
2. *Processing practices* are activities that change the form of a material. Processing may take place in any one of three major ways.
   a. *Separating* means taking away some material in order to achieve a change in form.
   b. *Forming* means rearranging a material to a different shape without the loss or addition of material.
   c. *Combining* is the union of two or more separate components or products into something more complex.
3. *Postprocessing practices* are activities that occur after a product has been manufactured. They may extend the life of the product, make it more useful to the customer, or change it to fit a new need. Often these practices are called "servicing."
   a. *Installing* means placing a manufactured product in some permanent way so that it can be used by a consumer.

b. *Maintaining* means "keeping." This kind of activity helps the product keep the quality or performance it had when it was new.
c. *Repairing* restores a product to its original condition or something like its original condition.
d. *Altering* means changing a product after manufacture so that it may be used for a new purpose or in a new or better way.

Laboratory Activity (25)

The class will see a set of transparencies that represent the five stages in producing newspapers. These five stages were mentioned in the textbook.

1. Divide the class into five teams, and let each team choose a name.
2. Explain that each team will compete with the other teams to name appropriate practices involved at each stage of production.
3. Have students look at Fig. 48-1 in the Laboratory Manual as you discuss the following examples:
   a. *Preprocessing* at Stage 4. What handling practice might be involved here? How was the roll of paper brought to the printing plant? By truck? By train? By boat? Use your imagination along with your knowledge about newspapers. The teacher will judge whether your answer can be "allowed" in scoring the game.
   b. *Processing* at Stage 1. What separating practice might be involved at this stage? How was bark removed? By water? By knife? By sawing?
4. Show Transparency 86-1, *Stage 1. Preparing Raw Materials*. Leave it on the screen for about 4 minutes while groups discuss and record answers for Stage 1.
5. Let each group present its answers. Each right answer is worth five points.
6. Have one student keep the scores.
7. Repeat the procedure for the other four transparencies: 86-2, *Stage 2. Making Industrial Materials*; 86-3, *Stage 3. Making Components*; 86-4, *Stage 4. Combining Components*; 86-5, *Stage 5. Preparing for Distribution.*

Homework

Reading 42, *Converting Raw Materials to Industrial Material*

ASSIGNMENT 87, ACTIVITY 49
READING 42

Converting Raw Materials to Industrial Materials

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a series of questions:
   a. Explain how two refining techniques, washing and cleaning, are used to free sand, gravel, ore, meat, vegetable, and fruit from unwanted materials.
   b. Explain how raw materials such as coal, gravel, eggs, and potatoes are separating by screening and sizing.
   c. Name some of the six processes used to remove coverings from fish, meat, fruit, etc.
   d. Name the four practices of bulking: measuring, weighing, collecting, and unitizing.
2. Given the term "converting," list three examples of changing refined raw materials into industrial materials.

Discussion

3. Given a list of descriptions and a list of terms:
   a. Identify descriptions of refining and of bulking.
   b. Select five terms that name refining techniques.

Laboratory Activity

4. Given a mixture of sand and aggregate, and the necessary equipment and supplies, screen-sort the mixture by size, measure, and record the results.
5. Given a mixture of iron filings and sand, and the necessary equipment and supplies, separate the iron from the sand magnetically.

Time Schedule

5 Overview
10 Discussion
30 Laboratory Activity

Equipment and Supplies for Discussion

Equipment

1 overhead projector/screen

Supplies

1 Tranparency 87, *Description and Terms*

Overview (5)

1. The last activity explained manufacturing production technology.
2. Today's text reading explained how raw materials are converted into industrial materials.
3. You will be asked to identify descriptions of refining and bulking and to name five refining techniques.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)		Supplies (Group of 5)	
Problem 1		**Problem 1**	
1	sieve screen set No. 87	16 oz.	random-mixed sand and aggregate (measured by volume)
1	16 oz. measuring cup	2 pcs.	heavy paper, approx. 24″ x 24″ (craft wrapping paper or equivalent)
1	coffee can *or* similar container		
Problem 2		**Problem 2**	
1	16 oz. measuring cup	1 oz.	iron filings
1	magnet	8 oz.	sand (measured by volume)
1	stirring rod (small stick)	1 pc.	heavy paper, approx. 24″ x 24″
		1	plastic bag, sandwich size
Problem 3		**Problem 3**	
1	1000 ml. capacity, flat-bottom boiling flask	2 oz.	soil *or* clay
1	rubber stopper for flask, with ¼″ tube hole	1 pc.	cardboard, approx. 4″ x 4″ with ¼″ hole
1 pc.	¼″ O.D. glass tubing approx. 3″ long (to fit stopper hole)		water
1 pc.	¼″ I.D. flexible tubing approx. 30″ long		
1	tripod ring stand, w/screen		
1	propane torch *or* other heat source/spark lighter		
1	16 oz. beaker *or* equivalent		
1 pr.	asbestos gloves		
Problem 4		**Problem 4**	
2	8 oz. Owens oval bottles *or*	1 pc.	filter paper
2	common narrow-necked 8 oz. bottles *and*	1 tsp.	chalk dust
1	8 oz. measuring cup		water
1	2 oz. funnel		
Problem 5		**Problem 5**	
2	8 oz. Owens oval bottles *or*	4 oz.	oil and water mixture *or*
2	common narrow-necked 8 oz. bottles *and*	3 oz.	water *and*
1	8 oz. measuring cup	1 oz.	oil
1	2 oz. funnel	1 pc.	filter paper
1	coffee can *or* similar container		

4. In today's activity you will learn about refining by performing screen sorting and magnetic separating practices.

Discussion (10)

Show Transparency 87, *Description and Terms,* and use the following questions to guide the discussion.

1. From the set of descriptions, select the one that best describes refining. (3)
2. From the set of descriptions, select the one that best describes bulking. (2)
3. From the set of seven terms, select five that name techniques of refining. (a, b, d, f, g)
4. From the set of seven terms, select two that name what is done with the by-products of refining. (c, e)

Laboratory Activity (30)

In this laboratory activity students will try refining by screen-sorting, by magnetic sorting, by distilling, and by two techniques of filtering.

1. Review the activities with your students, and explain the procedures as necessary.
2. Students will work in their groups of five.
3. Distribute necessary equipment and supplies. Either a permanent magnet or an electromagnet may be used in Problem 2.
4. At completion of activities, supervise the return of equipment and supplies, and the cleanup.
5. Allow 10 minutes for groups to discuss answers to Laboratory Manual questions.
6. If time permits, ask how sugar might be separated from sand. (By adding enough water to dissolve all the sugar; then carefully pouring out — decanting — the sugar water into another container. By putting the sugar-sand mixture in a strainer, then running water through it until all the sugar is washed away.)

Homework

Reading 43, *Making Industrial Materials into Standard Stock*

Note

Look ahead to Assignment 88 and prepare a sizing mixture. See Note under Laboratory Activity, Assignment 88.

Answers for Laboratory Manual

Problem 1

1. 16 oz.
2. No. The air spaces between large pieces were partly filled with the fine material when it was all mixed together.
3. Yes.
4. (Answers will vary.)
5. (Answers will vary.)
6. Discard or rerefine.

Problem 2

1. Only ferrous materials can be sorted. (Those that contain iron in a form that can be magnetized.)
2. (a) Iron (b) Sand
3. (a) Sand (b) Iron

Problem 3

1. Steam formed, travelled through the tubing, and condensed in the beaker.
2. Clear.
3. It remained in the flask.

Problem 4

1. Water.
2. Chalk dust.
3. No.
4. By distilling.

Problem 5

1. Filtering.
2. 4 oz.
3. (Answers will vary.)
4. (Answers will vary.)

ASSIGNMENT 88, ACTIVITY 50
READING 43

Making Industrial Materials into Standard Stock

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about making industrial materials into standard stock:
   a. Explain what would have to be done in order to build a bench without *standard* stock.
   b. Identify the kinds of standard stock which were used to manufacture your shoes, shirt, and kitchen chairs.

Discussion

2. Given a list of 10 items, identify which five are standard-stock items and which five are standard-parts items.

Laboratory Activity

3. Given the equipment and supplies, manufacture a sheet of standard-stock paper by performing mixing, screening, sizing, drying, and trimming operations.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1	plastic tote tray
1	egg beater
1	stirring stick
1	12″ rule
1	electric flatiron
1	screen (from ACTIVITY 49)
1	tablespoon
1 pr.	scissors
1	6″ hand roller *or* equivalent

Supplies (Group of 5)

6 tbsp.	liquid starch
20	12″ x 12″ paper towels
½ box	nonwet-strength tissues (180 sheets per box)*
1	plastic sheet
10 pcs.	8½″ x 11″ paper
1 qt.	sizing mixture, in a 14″ x 14″ pan (See note in Laboratory Activity instructions)
1 btl.	food coloring

*You may prefer to buy pulp. Some school-supply catalogs list several grades.

Overview (5)

Today's work concerns making industrial materials into standard stock.

1. The textbook reading gives examples of standard stock and processes for producing standard stock. The difference between standard stock and standard parts was explained.
2. I will explain further the difference between standard stock and standard parts.
3. You will be asked to identify five standard-stock and five standard-parts items.
4. You will manufacture a sheet of paper by performing mixing, screening, sizing, drying, and trimming operations.

Presentation (5)

In the reading you were introduced to the terms *standard stock* and *standard parts.*

1. Standard-stock items almost always require further processing before they are useful to the individual as a consumer.
2. Standard parts are made from standard stock. Standard parts usually need no further processing except assembly.
3. A roll of heavy steel wire would be an example of standard stock. The steel bolts made from this wire would be an example of standard parts.

Discussion (5)

I will list 10 items on the chalkboard. You will identify which five are standard-stock items and which five are standard-parts items.

1. (From the following list, select five standard-stock items and five standard-parts items for the discussion period. NOTE: The correct answers are shown in the second column for the teacher.)

Item	Standard Stock or Standard Part?
a. steel beam	(standard stock of steel mill)
b. "log" of paper	(standard stock of paper mill)
c. automobile tire	(standard part)
d. sheet of glass	(standard stock)
e. bolt of cloth	(standard stock)
f. safety pin	(standard part)
g. sulfur	(standard stock)
h. sheet of plastic	(standard stock)
i. rough-sawn lumber	(standard stock)
j. clutch	(standard part)
k. liquid nitrogen	(standard stock of chemical plant)
l. v-belt	(standard part)
m. transistor car radio	(standard part)
n. copper wire	(standard stock of copper mill)
o. bolt and nut	(standard part)
p. door handle	(standard part)
q. box of foam pellets	(standard stock)
r. cardboard box	(standard part)
s. ½ h.p. motor	(standard part)
t. a half-skin of leather	(standard stock)

Laboratory Activity (30)

Note

Before class, prepare a sizing mixture consisting of 7½ ounces of bone glue or hide glue in 5 pints of water. Allow the glue to soak until it is soft. Heat the solution until it is quite warm and stir until the glue is dissolved. Then add the mixture to 5 pints of cold water. This formula will supply you with 2 pints of mixture each for five student groups and should last all day. Put the mixture into a 14″ x 14″ aluminum pan made from a 16″ x 16″ piece of heavy aluminum foil.

Today students will simulate the manufacture of paper from raw material—pulp.

1. Explain to students that paper is made from wood pulp. The pulp is made by converting wood chips into a coarse, wet, and fibrous mixture. Unless you obtained commercially prepared pulp, they will substitute tissue-paper mixture for wood pulp.
2. Divide the students into groups of five.
3. Each student in each group is to form a sheet of paper.
4. Distribute the necessary equipment and supplies.
5. Each group will need hot water for preparing the pulp; this can be tap water. Students will also need a flatiron for this activity. One flatiron can be used for the class, or several students can bring in electric flatirons so that each group will have one.
6. Have students follow directions in their Laboratory Manual for ACTIVITY 50.
7. Each student will size his sheet of paper. After sizing the paper, students will be able to write on it. The sizing prevents the ink from soaking into the sheet. Without sizing, the paper is absorbent, like paper towels.

Homework

Review of Readings 29, 34, and 36-43 if optional Assignment 89 is used. If Assignment 89 is not used, there is no homework. Look at activities for days 91 and 92 to determine which lesson should be developed for presentation. Both activities are in the Laboratory Manual.

ASSIGNMENT 89 (OPTIONAL)

Review No. 5

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

Given the summaries of Readings 29, 34, and 36-43, ask and answer questions about establishing accident prevention programs, manufacturing personnel technology, working, advancing, and retiring, organized labor and collective bargaining, securing reproducible raw materials, extracting raw materials, harnessing energy from nature, manufacturing production technology, converting raw materials to industrial materials, and making industrial materials into standard stock.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to select one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking.
3. Have each group of students get together and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker, knowledgeable about accident prevention, hiring and training, or collective bargaining to talk to the class. Schedule the speaker for the first class period and tape record his talk so it can be played to your other classes.
5. Schedule a field trip to a manufacturing plant to see activities related to the above readings.

Homework

None

ASSIGNMENT 90

Test No. 5

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 5, select responses from a list of items related to concepts presented in Readings 29, 34, and 36-43.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Distribute answer sheets and have students fill in needed information.
4. Pass out test booklets. Caution students to keep them closed until you say "begin."
5. Read the directions for filling in answer blanks. Then direct students to open test booklets and begin.
6. Allow 35 minutes for completion. Collect answer sheets first; then test booklets, pencils, erasers, and eraser shields.
7. Review the test with students to provide feedback.

Homework

Reading 44, *Story of Primary Metal Products, or* Reading 45, *Story of Textile Mill Products.*

Note

Decide which of two possible activities you want students to perform tomorrow, and make the reading assignment accordingly.

Answers to Test No. 5

1. B	2. D	3. A	4. D	5. D	6. A	7. D	8. B	9. A
10. D	11. B	12. B	13. C	14. D	15. A	16. D	17. C	18. B
19. C	20. C	21. D	22. C	23. A	24. D	25. A	26. A	27. C
28. A	29. B	30. A	31. B	32. A	33. A	34. D	35. B	

ASSIGNMENT 91A, ACTIVITY 51A
READING 44

Story of Primary Metal Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a story about primary metals:
   a. Discuss how product designers were involved in the creation of steel foil.
   b. Explain why *research and development* personnel are important to the iron and steel industry.

Discussion

2. Given a demonstration on producing standard stock, explain the following:
   a. How impurities are removed from lead.
   b. Why sand is used for casting molten metal.
   c. How metal slabs are formed into sheet stock.

Laboratory Activity

3. Given a simulated raw material, lead:
   a. Melt the lead.
   b. Remove impurities.
   c. Cast the molten lead into a cavity.
   d. Roll the cooled lead into sheet stock.

Time Schedule

5	Overview
15	Demonstration
5	Discussion
20	Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Each student)

1 pr.	safety glasses *or* face shield

Equipment (Group of 5)

1	tripod ring stand
1	propane torch w/utility burner and flame spreader/lighter
1	skimmer
3	bricks
1	slip roll
5	1/4" x 1" x 12" strike bars
5 pc.	12" x 12" Transite *or* equivalent
1 pc.	12" x 24" Transite *or* equivalent
1	5" melting ladle
1 pr.	slip-joint pliers
1	hammer
1 pr.	asbestos gloves
1	bench rammer *or* 2" x 2" x 12" piece of scrap wood
1	foundry screen (fine)
1	12" rule
1	1 gal. bucket, for sand

Supplies (Group of 5)

5 lb.	pig lead
25 lb.	molding sand
1 lb.	nonsilica parting compound *or* talcum
5	mold patterns (24-pica slugs)
10 pcs.	½″ x 2″ x 6″ common lumber
10 pcs.	½″ x 2″ x 5″ common lumber
40	6d common nails
10	8″ x 8″ molding boards (½″ plywood)

Overview (5)

Today's material concerns the story of primary metal products.

1. In the reading, the term "primary industries" was defined. Various raw materials, products, methods of processing, product design and development, process engineering, and personnel were identified and described.
2. I will demonstrate the laboratory activity which involves melting a primary metal, casting it into a slab, and then rolling it into sheet stock.
3. You will be asked how impurities are removed from lead, why sand molds are used, and how slabs are formed into sheets.
4. You will then have the opportunity to cast a lead slab and roll it into sheet stock.

Demonstration (15)

Today the teacher will demonstrate heating a primary metal (lead) into a molten state, refining it by removing the impurities (slag), casting it into a slab, and rolling it into sheet stock.

1. Explain how to melt metal. Have the equipment for melting metal set up before class and the metal already heating.
2. While the metal is melting, explain how to ram a one-piece mold. Use the following steps as a guide.
   a. Set flask on bottom molding board.
   b. Place mold pattern inside flask.
   c. Sprinkle on parting compound (or talcum) to cover mold pattern.
   d. Screen sand until mold pattern is covered.
   e. Put in remaining sand and ram mold.
   f. Strike off excess sand.
   g. Place other molding board on flask. Holding flask and molding boards very tightly, turn over flask.
   h. Remove bottom molding board, then mold pattern.
3. When the lead is melted, demonstrate the procedure of refining the metal by skimming off the slag (impurities). Heat the skimmer to prevent it from spattering the metal.
4. Demonstrate how to pour the lead into the sand mold. Emphasize the use of the asbestos gloves. Care should be exercised not to pour too much metal into the mold.
5. Using a slab of lead cast previously, demonstrate how to adjust and use the slip roll to reduce the cast lead slab into sheet stock.

Discussion (5)

The students are about to duplicate what you have showed them in their laboratory activity. This discussion will reinforce points from the demonstration.

1. How are impurities removed from lead? (The lead is heated to its melting point. Then the impurities in the lead, being lighter than the metal, float to the surface of the metal. These impurities are then skimmed off mechanically.)
2. Why is a sand mold used for casting objects from molten metal? (It will conform to the shape of any desired die; it will hold the shape of the desired casting; and it will not melt or ignite when molten metal is poured into it.)
3. How are metal slabs formed into sheet stock? (The slab is rolled between two rollers. The distance between the rollers is reduced gradually so that the metal slab keeps getting thinner. Finally, it is flattened to a sheet of the desired thickness.)

Laboratory Activity (20)

1. Divide students into groups of five. Explain that each student will make a sand mold and cast a lead slab.
2. The foreman of each group will assign tasks as groups prepare to work.
3. Distribute equipment and supplies.
4. Only the students in the first class will need to perform the task "making one-piece flask."
5. Caution students to follow Laboratory Manual directions very carefully.
6. Caution the students to preheat the metal skimmer, before using it, to skim off impurities in the metal. If the skim-

mer is cold, it might cause the metal to spatter upon contact.

7. Allow five minutes for cooling before removing lead from a mold.
8. While the metal is cooling, your students may return the equipment and supplies they used to ram up the mold and write answers to the questions in their Laboratory Manuals.
9. Check the casting made by each group before allowing students to remove it from the mold. Caution the students to handle the casting with pliers, NOT with their hands.
10. Guide students in rolling the cast slabs into plate or sheet stock with a slip roll. A gradual increase in pressure of the rolls will form the slab into a uniform plate or sheet.
11. Supervise the return of equipment to its proper location and the laboratory cleanup.

Safety Precautions

1. Wear asbestos gloves and safety glasses when pouring melted metal.
2. Pour just enough molten lead to fill cavity.
3. There should be no moisture in the mold.
4. Heat skimmer before skimming slag.

Homework

Reading 46, *Story of Petroleum Products,* or Reading 47, *Story of Chemical Products.*

Answers for Laboratory Manual

1. 620°
2. Skimmer
3. Slabs
4. Rolling
5. Standard stock

ASSIGNMENT 91B, ACTIVITY 51B
READING 45

Story of Textile Mill Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a story about textile mills:
   a. Explain why nearly half of America's textile mills are located in North and South Carolina.
   b. List the textile products in your home which are natural and synthetic.

Discussion

2. Given a demonstration on refining cotton fibers, explain:
   a. Why must cotton fiber be refined before it is combed into strands?
   b. What do we mean when we say cotton is combed into strands?
   c. Why are we using a cleaning solution to clean the cotton fibers?
   d. Why is abrasive paper used for twisting the strands of fiber together?

Laboratory Activity

3. Given a natural fiber in raw form:
   a. Refine the fiber by removing the seeds and washing the material.
   b. Comb the refined fiber into yarn.

Time Schedule

5 Overview
10 Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 metal-bristled brush*
4 pocket combs

10 ¾″ x 2″ x 2″ wood blocks covered with 3/0 abrasive paper (Cut blocks from scrap; cement paper to surface.)

1 shallow container (metal baking pan, approx. 1½″ x 10″ x 10″)

1 3″ dia. funnel

*A dog brush is suitable

Supplies (Group of 5)

5 cotton balls (or bolls)

1 pt. cleaning solution (mineral spirits paint thinner), in stoppered, labeled container

1 pkg. paper towels

5 5″ cardboard mailing tube *or*

5 pcs. ¾″ dowel, 5″ long

Overview (5)

Today's material is concerned with the story of textile mill products.

1. The reading described the textile mill industry. Some raw materials, processes, and textile products were identified.
2. I will demonstrate refining a natural textile fiber and making it into yarn.
3. You will be asked to explain why cotton fibers are refined, and how they are combed, cleaned, and twisted into yarn.
4. You will then have the opportunity to refine a cotton boll.

Demonstration (10)

Today you will be refining a natural fiber, combing it, and making yarn.

1. You will clean the cotton boll by picking the seeds and the chaff from it. This process is performed commercially by a machine called a *cotton gin.* (Demonstrate picking the seeds and the chaff from the cotton boll.)
2. Fill the baking pan with about one pint of cleaning solution. (Demonstrate.) Immerse the refined cotton for about 30 seconds. Agitate the fiber gently.
3. Spread the fiber out on a flat, clear surface to dry. This will take 2 to 3 minutes. (While it is drying, answer any questions students may have.)
4. Brush and comb the dry cotton fiber into strands. (Be sure that all your students can see these operations.)
5. Place the combed strands of cotton between two abrasive blocks and form *one* strand. (Demonstrate how to form a continuous strand of yarn by shuffling the blocks gently together.)
6. Wind the yarn. (Demonstrate how to wind the yarn onto a dowel or a cardboard mailing tube as it is formed.) Be careful not to stretch the strand too tightly while winding it; too much tension will break the yarn.

Discussion (5)

Before students begin forming cotton bolls into yarn, reinforce the points they observed during the demonstration.

1. Why must cotton fiber be refined before it is combed into strands? (Chaff and seeds are present in the cotton boll as it is picked from the plant. These impurities would cause flaws in the cotton yarn if they were not removed.)
2. What do we mean when we say cotton is combed into strands? (Combing is the process of straightening out the twisted fibers of the cotton boll into long, parallel strands of uniform thickness.)
3. Why are we using a cleaning solution to clean the cotton fibers? (It will clean the fibers without very much stirring or agitation. It will evaporate rapidly from the fibers so they can be combed into strands.)
4. Why is abrasive paper used for twisting the strands of fiber together into yarn? (It has a rough surface; it will grip the cotton fibers gently.)

Laboratory Activity (25)

Today the students will produce a primary textile product by refining, combing, and twisting cotton fibers into yarn.

1. Students will assemble in their regular groups.
2. Distribute equipment and supplies. Each student will be given one boll of cotton.
3. Direct students to pick chaff and seeds from the cotton bolls.
4. Students will then pour fluid into the shallow pan and wash the cotton.
5. While the cotton is drying on paper towels, students are to pour the fluid back into its container (using a funnel), stopper the container, and return it to a central place. Observe, to be sure they are handling the fluid carefully.
6. After the fiber is cleaned and dry, remind the students to comb it gently into strands. Short strokes should be used at first. As the cotton fibers become

separated, longer strokes should be used until the fibers are parallel.

7. As students twist the strands of fiber together, caution them not to apply heavy pressure to the abrasive blocks. Too much pressure will abrade the cotton fiber.
8. Students will wind the yarn onto its spool as they form it.
9. See that equipment is returned and the waste is disposed of.
10. Allow time for completing questions in the Laboratory Manual.

Homework

Reading 46, *Story of Petroleum Products*, *or* Reading 47, *Story of Chemical Products*.

Answers for Laboratory Manual

1. Refining
2. Combing
3. Twisting
4. Boll
5. Fiber

ASSIGNMENT 92A, ACTIVITY 52
READING 46

Story of Petroleum Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a story about the production of petroleum:
   a. Explain why petroleum is a *nonreproducible* mineral resource.
   b. List the petroleum and petrochemical products used in your home.

Discussion

2. Given a demonstration on reprocessing contaminated oil, name the three practices used to remove physical impurities from the oil.

Laboratory Activity

3. Given a quart of contaminated oil, reprocess the oil by filtering, magnetic cleaning, and siphoning.

Time Schedule

5 Overview
15 Demonstration
5 Discussion
20 Laboratory Activity

Note

Assignment 92 has two alternatives:

1. Assignment 92A, Activity 52, has a Laboratory Manual activity on reprocessing oil.
2. Assignment 92B is a demonstration on making nylon fiber.

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1	3″ dia. funnel
2	1000 ml. glass beaker
1	6″ bar magnet
1 pc.	flexible tubing for siphon
1 pr.	long-nosed pliers

Supplies (Group of 5)

1 pc.	4″ x 4″ cardboard
1 qt.	contaminated oil in quart jar (10W oil)
1 pc.	5″ x 5″ cloth
½ lb.	sand and gravel mixture
1 pkg.	paper towels
1	12″ length of string
1	plastic sheet

Overview (5)

1. The reading described the origin of petroleum and many petroleum products. The extracting, transporting, and refining of crude oil were explained.
2. I will demonstrate how to reprocess contaminated oil.
3. You will be asked about practices used to reprocess contaminated oil.
4. You will then reprocess contaminated oil.

Demonstration (15)

Oil never wears out, but it becomes contaminated with use. Therefore, it must be refined if it is to be used again. Today I will demonstrate how to refine contaminated oil. (Explain each step as you demonstrate.)

1. Spread a plastic sheet over the bench top.
2. Obtain a quart of contaminated motor oil. (See Laboratory Activity section.) Shake it well to suspend all of the impurities in the oil.
3. Place the piece of cloth into the funnel and add the sand and gravel mixture to the funnel. This will serve as a filter.
4. Place the funnel over the glass beaker. Punch a hole in the 4″ x 4″ piece of cardboard to support the funnel over the beaker.
5. Pour oil into the funnel, a little at a time, until about one half of the quart has been filtered.
6. Obtain a 6″ bar magnet. Move the magnet through the filtered oil. Any steel particle in the oil should be attracted to the magnet.
7. Wipe the metal particles off the magnet with *paper towels;* do not use anything else.
8. Allow the filtered oil to stand in the glass beaker for about 5 minutes. While it is standing, discard the filtering mixture and clean the magnet and funnel.
9. In about 5 minutes the oil will have risen above the water. The next step is to remove the water which has settled below the oil. Siphon out the water using a piece of flexible tubing, as follows: Fill the tubing with water. Hold one end closed with the pliers. Be careful not to allow air to enter the tubing. Insert the pliers and tube end into the beaker until it reaches the water at the bottom of the beaker. The other end of the tubing should be placed into an empty beaker.
10. In the petroleum industry after the physical impurities have been removed, the next step in reprocessing contaminated oil is to remove the chemical impurities. Due to the dangers involved, we will not perform this step.
11. The refining operations are now complete. Compare the refined oil with the remaining contaminated oil in the original container. They will be different to sight, smell, and touch.

Discussion (5)

The students are about to begin a laboratory activity in which they will refine contaminated oil. This discussion will reinforce points they observed during the demonstration, which will apply to their laboratory activity.

1. Physical impurities were removed from the contaminated oil by what steps in the demonstration? (Filtering, magnetic cleaning, and siphoning.)
2. Why can contaminated oil be reprocessed for later use? (Motor oil never wears out.)
3. Why must motor oil in an auto be changed? (It becomes contaminated with impurities.)

Laboratory Activity (25)

Today the students will refine contaminated oil by filtration, magnetic cleaning, and siphoning.

1. Before class prepare contaminated oil by adding 2 tablespoons of iron filings, 2 tablespoons of sand, and ½ pint of water to 1 quart of 10W oil.
2. Assemble students in their work groups.
3. Distribute equipment and supplies.
4. Caution the students to be careful when removing metal particles from the oil with a magnet. Since the oil is in a glass beaker, the magnet could crack the glass.
5. If the magnets are very small, have students tie a 12″ length of string around each magnet.
6. Iron filings are to be removed from magnets with paper towels.
7. Remind students to allow the filtered oil to rise in the glass beaker for about five minutes before they begin removing the water, which will settle to the bottom. If they attempt to siphon off the water any earlier. it will not have settled to the bottom of the container.
8. See that all waste is disposed of in the proper container.
9. Allow time for completing questions in the Laboratory Manual.

Safety Precautions

1. The glass jars and beakers are breakable.
2. Oil stains on clothes are not removable.

Homework

Reading 48, *Making Components by Forming or Separating Standard Stock*

Answers for Laboratory Manual

1. a. Is lighter in color.
   b. Does not have an alcohol odor.
   c. Does not have visible suspended particles.
   d. Feels smoother, not gritty.
2. Magnet.
3. Below.
4. Wears.

ASSIGNMENT 92B, READING 47

Story of Chemical Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given a story about chemical products:
   a. Discuss why the chemical industry has depended more on research and development than other large industries.
   b. List the chemical products used in your home.

Discussion

2. Given a demonstration of how to make a polymeric film by polymerization:
   a. Identify the process.
   b. Describe how the polymeric film is formed.
   c. Explain how the material is to be used.

Time Schedule

5	Overview
30	Presentation–Demonstration
10	Discussion

Equipment and Supplies for Demonstration

Equipment (Demonstration 1)

1 pr.	tweezers
5 pr.	rubber gloves
1	200 ml., tall-form beaker (2¼″ inner diameter)
1	100 ml. volumetric pipet, w/rubber bulb
2	100 ml. beakers
1	covered metal waste can, for disposal of materials

Supplies (Demonstration 1)

2 ml.	sebacoyl chloride (Eastman Kodak #6236)
100 ml.	carbon tetrachloride azobenzene (a few drops for color)
4.4 gm.	hexamethylene diamine (Eastman Kodak #P5932)
1 pt.	50% aqueous alcohol *or* acetone
50 ml.	water
1 pkg.	paper towels
1 bundle	newspapers

Equipment (Demonstration 2, optional)

1 pr.	tweezers
5 pr.	rubber gloves
1	200 ml. tall-form beaker (2¼" inner diameter)
1	100 ml. volumetric pipet, w/rubber bulb
2	100 ml. beakers
1	covered metal waste can, for disposal of materials
1	ring stand to support tall beaker
1	support device w/two glass rods

Supplies (Demonstration 2, optional)

1.5 ml.	sebacoyl chloride (Eastman Kodak #6236)
50 ml.	tetrachloroethylene
2.2 gm.	hexamethylene diamine (Eastman Kodak #P5932)
4.0 gm.	sodium carbonate
1 pt.	50% aqueous alcohol *or* acetone
50 ml.	water
1 pkg.	paper towels
1 bundle	newspapers
	azobenzene (a few drops for color)

Overview (5)

Today's material concerns the story of chemical products.

1. In the textbook you read about chemical raw materials and how industry uses chemical products. Chemical processing and chemical transformations were explained. The research and development and production control phases were described, and the personnel were identified.
2. I will demonstrate the making of a nylon fiber by polymerization.
3. You will be asked to discuss parts of the demonstration.
4. There is no structured laboratory activity, but several members of the class will be asked to help pull the nylon fiber from the chemical solution.

Presentation - Demonstration (30)

Introduction

1. In your reading you learned about several kinds of processes that transform or change one chemical into another. Today I will demonstrate one of these processes: it is called *polymerizing* or making a *polymer.*
2. It is a chemical process in which small molecules are joined to form large molecules. It is a very important chemical process; most kinds of plastic are formed by polymerizing or *polymerization.*
3. The word "poly" means "many," and "polymerizing" means literally something like "many small parts put together."
4. You will see on a small scale how a *polymeric* film is produced. Industry uses the same general process on a large scale, but the details are different. Sometimes one solution is *injected* or "shot" under pressure through the other solution.

Demonstration 1

Perform the demonstration as outlined here. Work on an acid-resistant surface. It is recommended that you perform the whole procedure prior to the day it is to be demonstrated. See Safety Precautions.

1. Preparing Solutions
   a. Prepare the organic solvent. Mix 2 ml. sebacoyl chloride in 100 ml. carbon tetrachloride. (See Safety Precautions.)
   b. Prepare the aqueous solution. Mix 4.4 grams hexamethylene diamine in 50 ml. water.
   c. Add azobenzene to the organic solvent. This will give color to the solution and enhance the visibility of the liquid interface.
2. Mixing Phases (Solutions)
   a. Place the organic solvent phase in a 200 ml. tall-form beaker.
   b. Carefully pour the aqueous phase over the organic solvent phase. This aqueous phase, being lighter than the organic solvent phase, will float on top.
3. Obtaining Polymer
   a. A *polymeric* film will form at once at the interface. This film usually is irregular and contains air sacs and bubbles. Be sure that all your students are grouped so they can watch it form.
   b. Remove this irregular film.
4. Forming Nylon Fiber
   a. Using a pair of tweezers, grasp the chemical mass at the center and pull upward.
   b. The film will always form a tent with draping and shifting folds. The apex

will be at the air-liquid interface. See Fig. 92-1.

Note

At this point you may wish to have several students pull out the nylon, rope-like film. See Fig. 92B-2 for optional method.

5. Cleaning and Drying
   a. Wash the fiber thoroughly with a 50% aqueous alcohol or acetone solution.
   b. Allow the fiber to dry in the air.

Demonstration 2

1. Preparing Solutions
   a. Prepare the organic solvent. Mix 1.5 ml. sebacoyl chloride in 50 ml. tetrachloroethylene.
   b. Prepare the aqueous solution. Mix 2.2 grams hexamethylene diamine and 4.0 grams sodium carbonate in 50 ml. water.
   c. Add azobenzene to the organic solvent.
2. Mixing Phases (Solutions)
   a. Place the organic solvent phase in a 200 ml. tall-form beaker.
   b. Carefully pour the aqueous phase over the organic solvent phase.
3. Obtaining Polymer
   a. A polymeric film will form at once at the interface.
   b. remove this irregular film.

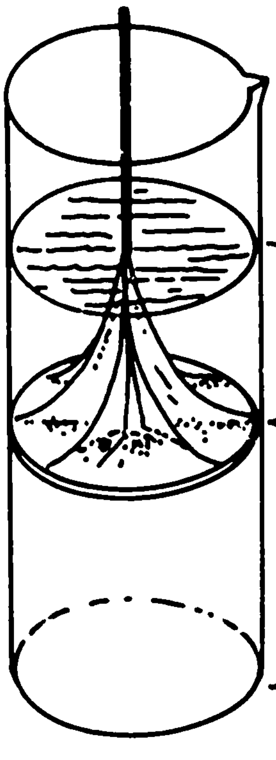


Fig. 92B-1. Pulling Polymer Film

4. Forming Nylon Fiber
   a. Using a pair of tweezers, grasp the chemical mass at the center and pull upward.
   b. Conduct the film from the center of the beakers over a glass rod or tube, and then out and down over a second rod. A drop of about 3' to 4' is necessary for the film to flow continously. The glass rod or tube must have a very smooth surface. See Fig. 92B-3.
5. Cleaning and Drying
   a. Wash the fiber thoroughly with a 50% aqueous alcohol or acetone solution.
   b. Allow the fiber to dry in the air.

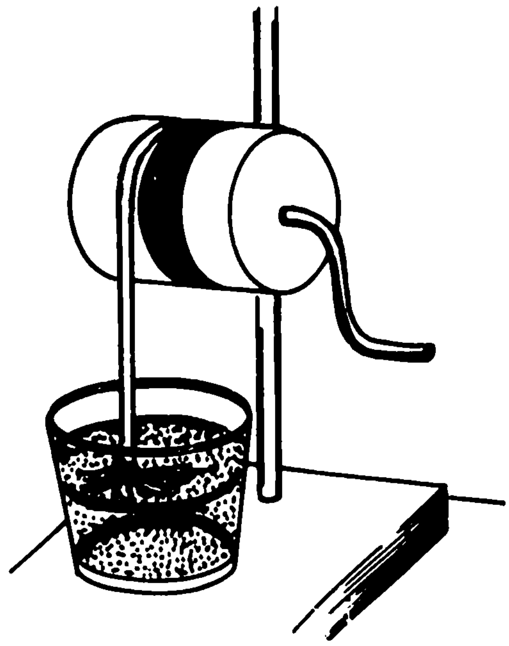


Fig. 92B-2. Manual Winding Device for Continuously Removing Polyamide Film from an Interface

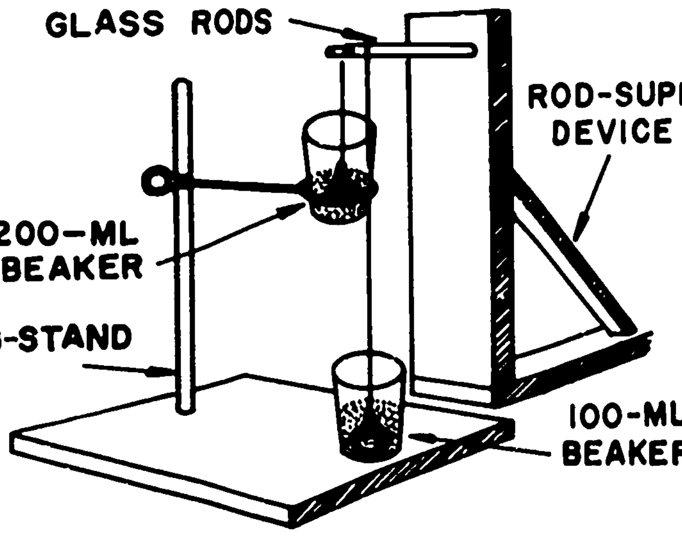


Fig. 92B-3. Continuous Flow of Nylon Fiber

Discussion (10)

Using the following questions, reinforce the main points the students observed during the demonstration.

1. What chemical transformation did you see today? (Polymerizing or polymerization.)
2. What happens in polymerization? (Small molecules are joined to form large molecules.)
3. If we used the two chemical solutions separately, could we obtain a nylon film? (No, they must be mixed.)
4. When the two chemical solutions were mixed, where did the polymeric film form? (At the *interface*: the surface where the solutions met.)
5. When did the rope-like fiber form? (When the chemical mass was grasped in the center and pulled upward. The rope forms as this mass is pulled through the aqueous solution.)
6. Is this ropelike fiber a raw material or a finished product? (A raw material.)

Safety Precautions

1. Wear rubber gloves.
2. Perform demonstrations on a stone or other acid-resistant bench top, a glass plate, or a thick pad of newspapers.
3. When chemicals are measured with the pipet, use rubber bulbs. Never use your mouth to draw up the fluid.
4. The demonstration should be performed under a hood or in a large, well-ventilated room.
5. The chemical residues should be disposed of after the demonstration or placed in a closed container.
6. Avoid breathing vapors of carbon tetrachloride, as well as having skin contact with this solvent.
7. *Do not* use any heat of any type for this demonstration.
8. The rope of polymer film should be handled only with rubber gloves, tongs, and forceps until it has been washed free of solvent and reactants.
9. If the polymer material is accidentally handled before it is washed, wash hands well to remove solvent and reactants.
10. Any used polymerization mixture should not be poured into a sink, but should be stirred until no further polymer forms.
11. If acid chloride solutions are mixed and stored prior to demonstration, they should be kept in brown bottles and out of strong light.
12. At the end of the day dispose of all chemical solutions prepared for demonstration. (Hydrogen chloride fumes may form in acid chloride solutions if stored.)
13. See your school chemistry instructor for aid in storing and disposing of all chemicals used in the experiment.

Homework

Reading 48, *Making Components by Forming or Separating Standard Stock*

Note

1. Cut 2″ x 2″ pieces of 36 gage aluminum foil for ACTIVITY 54, Assignment 95.
2. For Assignment 93 (optional), it is suggested that you cut a copy of the product you are working on from the *Product Illustration Sheet.*
3. Cut out a piece of acetate or cardboard the same diameter as the inside of the *Product Process Chart.*
4. Glue or fasten the picture of the product in the center of the acetate or cardboard circle. Fasten this circle to the chart so it can be taken off and replaced by another one.
5. While you are manufacturing that product, you can draw lines, or arrows, or rotate the wheel in many different ways to show the progress of production, and to reinforce the concepts that you are teaching.

ASSIGNMENT 93 (OPTIONAL)

Introduction to Second Semester

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Using the Table of Contents and a wall chart, *name several products to be manufactured and several manufacturing processes that will be used.*

Laboratory Activity

2. Complete all unfinished laboratory work.

Time Schedule

5 Overview
20 Presentation-Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation-Discussion

Supplies (Per teacher)

1 Product Process Chart No. 93-1
2 Product Illustration Sheet No. 93-2

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 marking pen, fine point, different color for each class period

Supplies (Each student)

1 Laboratory Manual

Overview (5)

1. In the first semester you learned how manufacturers *plan, organize, and control* the development of products and processes. This semester we will learn how manufacturers *produce products and establish a corporation.* Today I will tell you about the products you will be manufacturing this semester.
2. We will discuss briefly some processes you will be using to manufacture the products.
3. In the laboratory activity, you can complete any unfinished work.

Presentation-Discussion (20)

1. Display the Product Process Chart and Product Illustration Sheets. Talk briefly about the products students will manufacture during the second semester. If any prepared sample products are available, show them. If samples are not available, refer to the Laboratory Manual and the illustrations on the chart.
   a. Soft-faced mallet
   b. Brick
   c. Screwdriver
   d. Vacuum-formed object
   e. Personalized note pad
   f. House marker
   g. Etched glass
   h. Autograph book
   i. Balloon
   j. High-intensity lamp
   k. Utility box
   l. Sponge
   m. Sticker
   n. I.D. tag
2. Explain to the students that some components will be made and stored, then combined and coated later, just as in industry.

Laboratory Activity (20)

1. Today you can complete any unfinished work. First semester work should be completed prior to starting the second semester.

Homework

Reading 48, *Making Components by Forming or Separating Standard Stock*

Note

1. Cut 2" x 2" pieces of 36 gage aluminum foil for ACTIVITY 54, Assignment 95.
2. For Assignment 93 (optional), it is suggested that you cut a copy of the product you are working on from the *Product Illustration Sheet.*
3. Cut out a piece of acetate or cardboard the same diameter as the inside of the *Product Process Chart.*
4. Glue or fasten the picture of the product in the center of the acetate or cardboard circle. Fasten this circle to the chart so it can be taken off and replaced by another one.
5. While you are manufacturing that product, you can draw lines, or arrows, or rotate the wheel in many different ways to show the progress of production, and to reinforce the concepts that you are teaching.

ASSIGNMENT 94, ACTIVITY 53
READING 48

Making Components by Forming or Separating Standard Stock

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about making components by forming or separating:
   a. Identify two one-piece products around your home that have been manufactured by forming or separating.
   b. Select any assembled product in your house where most of the parts can be seen, and count the number of parts in the product.

Discussion

2. Using a filmstrip presentation, identify:
   a. Raw materials.
   b. Standard stock.
   c. Components.
   d. Subassemblies.
   e. Assemblies.
   f. Finished products.

Laboratory Activity

3. Given 20 illustrations of manufacturing processes, identify the stage of production represented in each picture.

Time Schedule

5 Overview
25 Filmstrip Presentation
5 Discussion
10 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation

Equipment

1 filmstrip projector w/screen

Supplies

1 Filmstrip 94, *Raw Material, Standard Stock, Component, Subassembly, Assembly, Finished Product*

Overview (5)

1. Yesterday you were introduced to some of the products and processes you will be learning about.
2. You have read that a component is one part of a product. Some products have many components, some have only one. All materials are made into components by either a forming or a separating process, sometimes by both. The manufacturer considers the material properties, the quantity wanted, and the surfaces and tolerances needed, to determine the most economical way to make components. The components are then combined to make subassemblies and assemblies.
3. I will show and discuss a filmstrip showing materials in different stages of production.
4. You will be asked to define *raw material, standard stock, component, subassembly,* and *assembly.*
5. In the Laboratory Manual you will identify the stages of production represented in illustrations.

Filmstrip Presentation (25)

Materials go through various stages of refinement and fabrication during manufacturing processes. These stages can be classified as raw material, standard stock, components or finished products, subassemblies, or assemblies. The filmstrip, *Raw Material, Standard Stock*, which you are about to see, will help you learn to identify these stages.

Script for Filmstrip No. 94 — 29 Frames

First, you will see several kinds of raw materials.

Frame No.

1. Focus.
2. The World of Manufacturing.
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois

4. *Raw Material, Standard Stock, Component, Subassembly, Assembly, Finished Product*
5. Some raw materials, such as wool, come from animals.
6. Other raw materials come from living vegetation. This is a boll of cotton.
7. This frame shows wood chips, used in the manufacture of paper, being dumped from a big truck.
8. Iron is one of many kinds of metals that is *extracted* as raw material in the form of ore.

These raw materials and many more are *converted* to standard stock by the "primary industries." Now let us look at a few samples of *standard stock.*

9. Large rolls of paper are standard stock used by many printing industries.
10. This standard stock is tire-cord fabric being woven and rolled for storage. Textiles are often produced as very long pieces which are wound around a tube or spool for convenience.
11. Trees are sawed into rough lumber, which is then resawed to various standard sizes.
12. Metal standard stock often comes in the form of large coils. Tubes, sheets, plates, and angles are other common forms. The standard stock for cast metals is usually in the form of pigs or ingots.

Standard stock is converted into either *components* or *one-piece products.* A component is one part of a product.

13. These glass jars are examples of one-piece products, but they will become components when lids are attached.
14. Most of these metal components will be *assembled* with other components to produce a finished product.

When components are combined to produce sections or parts of a product, we have what is called a "subassembly." If a manufacturing plant combines components into subassemblies, the subassemblies can be thought of as a finished product *for that company.*

15. The bicycle seat shown in this frame is a subassembly. However, in a bicycle seat factory it would be thought of as a finished product.
16. This is a subassembly of a T-38 fuselage. This is a *finished product* to this specific production plant, because the fuselage is being shipped to another plant for final assembly into a complete airplane.

The term "assembly" applies to durable goods that have been produced by joining components or subassemblies. The components can be joined either rigidly or as moving parts. Assemblies are also finished products.

17. This tractor is an assembly. It is produced by combining many components and subassemblies.
18. This giant shovel gives you an idea of how large an assembly can be.

You have seen some examples of raw materials, standard stock, components or finished products, subassemblies, and assemblies. Now, as you look at each of the following frames, see if you can identify what stage of *refinement* or *fabrication* is shown.

19. Standard stock.
20. Subassembly.
21. Assembly (or finished product).
22. Components (and finished product).
23. Raw material (lumber).
24. Components, subassemblies and assembly.
25. Subassembly (instrument panel).
26. Assembly (offset duplicator).
27. Raw material (cotton).
28. Assembly.
29. Credits.

Discussion (5)

1. What is raw material? (Material from nature which has not yet been processed into standard stock.)
2. What is standard stock? (Material produced by the primary industries, in certain standard sizes and shapes. Most of it will be further processed into components.)
3. What is a component? (One part of a product.)
4. What is a subassembly? (Two or more components, combined to produce sections or parts of durable goods.)
5. What is an assembly? (A product that has been produced by combining components or subassemblies.)

Laboratory Activity (10)

1. During today's Laboratory Activity, the students will identify the stage of production indicated in each of 20 pictures in the Laboratory Manual.

Homework

Reading 49, *Material Forming Practices*

Answers for Laboratory Manual

1. Subassembly	6. Raw material	11. Assembly	16. Component
2. Standard stock	7. Components	12. Subassembly	17. Raw material
3. Subassembly	8. Raw material	13. Raw material	18. Assembly
4. Assembly	9. Components	14. Component	19. Raw material
5. Standard stock	10. Assembly	15. Subassembly	20. Subassembly

ASSIGNMENT 95, ACTIVITY 54
READING 49

Material Forming Practices

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using information about material forming processes:
   a. Identify a product or part of a product that has been formed by: (1) casting or molding, (2) compressing or stretching, or (3) by material conditioning.
   b. Identify products around the home that have been made by: (1) forming, (2) bending, or (3) drawing.

Discussion

2. Using a filmstrip presentation:
   a. Explain forming.
   b. Describe the three major ways of forming.
   c. Describe casting or molding.
   d. Name six processes that compress or stretch materials.
   e. Describe what happens in material conditioning.
   f. Name three ways in which material is conditioned.

Laboratory Activity

3. Using the necessary equipment and supplies:
   a. Draw-form a metal mold that can be used for casting clear plastic resin.
   b. Condition a clear plastic resin and cast it into the metal mold.

Time Schedule

5 Overview
15 Filmstrip Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation

Equipment (Per teacher)

1 filmstrip projector w/screen

Supplies (Per teacher)
1 Filmstrip 95, *Forming Processes*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)
1 No. 95 draw die
1 plastic or rubber mallet

Supplies (Group of 5)
5 pcs. 2″ x 2″ 36 gage soft aluminum foil
1 paper cup, 3 oz.
1 stirring stick
1½ oz. liquid casting plastic and hardener
transparent dye (optional)
1 quick set promoter

Overview (5)

1. Yesterday you learned that components are made from standard stock by forming and separating.
2. Your reading named the three basic ways of forming: (1) *casting or molding*, (2) *compressing or stretching*, and (3) *conditioning*.
3. Today you will see a filmstrip that shows *how components are made from standard stock by forming.*
4. During the discussion you will be asked to explain (1) casting and molding, (2) compressing and stretching, and (3) conditioning.
5. In today's laboratory activity you will perform all three practices of forming: (1) casting or molding, (2) compressing or stretching, and (3) conditioning.

Filmstrip Presentation (15)

Today you will see a filmstrip about forming processes.

Script for Filmstrip No. 95 — 25 Frames

Frame No.

1. Focus.
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
The Ohio State University
Produced by
McKnight & McKnight
Publishing Company
Bloomington, Illinois
4. *Forming Processes*
5. *Forming* and *separating* are the two groups of processes that are used to make components from standard stock.
6. *Forming* usually means changing the shape of a piece of material. A forming process starts with a single piece of solid material, or with a given amount of liquid or powder. At the end of the forming process there is still the same amount of material in the piece, but some change has taken place.
7. All the forming processes can be put into one of three groups: *casting or molding*, *compressing or stretching*, and *conditioning*.
8. Many *casting* or *molding* processes involve pouring a liquid into a mold. The mold encloses a *cavity* or hole that has the size and shape of the desired component. When the material cools below its melting temperature, it "cures." Curing is the process of becoming solid and retaining the shape of the cavity.
9. This picture shows molten iron being poured from a ladle into the cavities of molds. After the metal cools and hardens to the shape of the cavity, the mold is broken to remove the casting. This is a *one-shot* molding process: the broken mold will not be used again.
10. These irregular shapes were cast. It would cost a great deal to machine these same shapes from a solid piece of standard stock.
11. Liquid clay is being poured into cup-handle molds. After the clay dries properly, the molds are opened to remove the components. This is one type of *permanent-mold* process: the same mold will be used again. The opened mold shows how more than one component can be cast at the same time.
12. and 13.
Compressing or *stretching* processes force solid or plastic material into the desired shape. In some processes the material is formed at room temperature. Sometimes it is heated to a temperature below its melting point to make it more ductile.
14. Some components are forced into shape from a very large piece of standard stock. Here cylindrical stock is being shaped into components with a 2,000-pound hammer. This is a *forging* process.

15. This irregularly shaped component was forged from a bulky piece of standard stock. It has great strength and light weight.
16. Round rod, held by the worker, is automatically *bent* by the machine. The rod is then *combined* with *components*.
17. Sometimes material is *pushed* and *pulled* into the desired shape. Here we see part of a 250-ton press making components for snow plows. This is a *drawing* process.
18. *Conditioning* processes change the internal properties or characteristics of a material. Usually there is no visible or external sign of change.
19. Magnetizing is a *physical* conditioning process.

    Step 1. A metal component is placed inside of an electromagnetic device.

    Step 2. Direct current is applied to the electromagnet to align all of the molecules of the component *in one direction*.

    Step 3. The current is suddenly turned off to freeze all of the molecules in a north-south position.

    Step 4. The component is now magnetized.
20. The teeth of this large gear are being flame-hardened. This is a *thermal* conditioning process.
21. This desk-calendar base will keep its form because it is a thermoplastic material that "cures" or hardens. This is an example of a *chemical-reaction* process.

22, 23, and 24.
All material-forming practices can be classified as shown in this frame. Read the outlined classification.

25. Credits.

Discussion (5)

1. What is *forming*? (Changing a piece or a given amount of material without adding or taking away any material is called *forming*. Usually the shape of the material changes during the forming process).
2. What are the *three* major ways of forming? (1 — casting or molding; 2 — compressing or stretching, and 3 — conditioning materials.)
3. What happens in a *casting* or *molding* process? (Usually a liquid, or something that flows like a liquid, is poured into a hollow mold. The hole or cavity in the mold has the size and shape of the component to be cast.)
4. What processes *compress* or *stretch* materials? (Forging, rolling, compression molding, bending, and drawing processes.)
5. What happens when material is *conditioned*? (Material-conditioning processes change the internal properties or characteristics of a material, usually without any visible or external sign of change.)
6. What are some *ways* in which material is conditioned? (By a chemical reaction, an internal physical change, or a thermal-conditioning process.)

Laboratory Activity (20)

Today students will be performing three practices of forming.

1. Have the students, working in groups of five, form the metal molds prior to casting the resin.
2. Show the students how to load, form and eject the aluminum molds. Emphasize this as *draw-forming*.
3. The teacher should mix resin and hardener and distribute to group foreman.
4. Students may wish to imbed a small coin, stone, ring, washer, nut, sawdust or metal chips.
5. If you are going to imbed an object, mix only enough resin, hardener, and promoter to *half-fill* the mold.
6. After students have imbedded object, mix and distribute remainder of resin and hardener to foreman.
7. If teacher is to store components, use a cardboard box, etc.

Safety Precautions

1. Be sure that the room is as well-ventilated as possible.
2. Do not get resin or hardener on hands or clothing.
3. Caution students to keep plastic resins away from open flames.

Homework

Reading 50, *Casting or Molding*

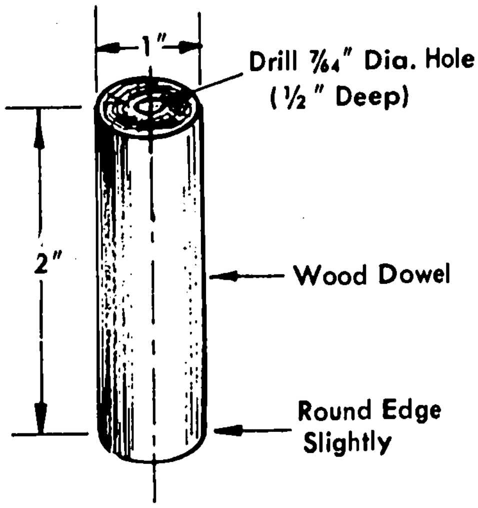


Fig. 95-1. Pattern

Note

For Assignment 97, be sure equipment and supplies are on hand for the demonstration of ramming a mold. Twenty-five patterns should be made now. See Fig. 95-1.

ASSIGNMENT 96, ACTIVITY 55A
READING 50

Casting or Molding

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about casting or molding:
   a. Identify three products in the home that have been made by casting or molding.
   b. Identify which of these products have been done by one-shot casting and permanent-mold casting processes.

Laboratory Activity

2. Given a permanent mold and the ingredients for sand-mix cement, cast two to four concrete bricks per group to demonstrate a permanent-mold casting process.

Time Schedule

5 Overview
10 Filmstrip Presentation
30 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation

Equipment (Per teacher)

1 35mm. filmstrip projector w/screen

Supplies (Per teacher)

1 Filmstrip 96, *Casting or Molding*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

2 brick molds
4 pcs. 1/4" x 5" x 10" tempered hardboard, cover board
1 plastic tote tray
1 1 qt. measure
2 pointing trowels
1 plastic bucket

184

Supplies (Group of 5)

1 qt. Portland cement
4 qt. sand
½ qt. water
1 1" brush
used *or* new machine (or cutting) oil
1 plastic dropcloth, *or* newspapers

Overview (5)

1. Yesterday you were introduced to material forming practices.
2. You have also read about one type of forming process called *casting or molding*.
3. Today you will begin a series of assignments on casting or molding in order to get a better understanding of how this practice is used by industry to shape material.
4. I will first show a filmstrip on *casting or molding*.
5. In the Laboratory Activity you will use a *permanent-mold casting* process to cast several bricks.
6. You will be asked a few questions about *permanent-mold casting*.

Filmstrip Presentation (10)

Today's assignment will explore the major casting or molding processes. Ask students to observe each operation carefully because they will be performing some of them during the next few days.

Script for Filmstrip No. 96 — 28 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Casting or Molding*

   Casting or molding usually involves pouring or forcing of a material into a mold. The mold contains a cavity of the size and shape wanted in some part. The material may be a liquid or a powder.
5. Casting or molding consists of *one-shot* molding processes and *permanent-mold* processes. In a one-shot molding process, the mold is destroyed after a single use.
6. Some of the major one-shot molding processes are *sand casting, shell-mold casting,* and *investment casting.* The *"on-site" placing of concrete* is also a one-shot molding process.
7. *Sand casting* involves making a pattern, ramming a two-part sand mold, melting the material, and pouring the molten material into the mold. This frame shows a mold for sand casting.
8. This man is making a pattern for sand casting. The shape of some components makes it necessary to cut the pattern into several pieces.
9. After the pattern has been made, the next step is to *ram* a two-part mold. This worker is using a pneumatic-powered molding machine to ram the molding sand around the pattern in the two-part flask.
10. The next step is to melt the metal. Here we see workers tapping a coreless furnace. The molten metal is being poured into a large ladle.
11. The ladle is then moved to the pouring area, and the molten metal is poured into the molds.
12. *Shell-mold casting* is a modified version of sand casting. The liquid material is poured into a two-part, lightly constructed sand mold. The sand is bonded together by hardened resin.
13. This machine is used for making shell-mold cores. The process of making the hollow sand core is quite similar to that used for making a two-part shell mold.
14. *Investment casting* is used for delicate work. It consists of making a pattern from wax or frozen mercury, *"investing"* a slurry around the pattern, melting the pattern so it runs out of the mold, and finally, pouring the mold.
15. Investment casting is used with very hard materials such as those used in turbine rotor blades. It is also used in delicate work such as jewelry and dental fixtures.
16. The major permanent-mold processes are *permanent-mold casting, die casting, injection molding,* and variations such as *centrifugal casting* and *slush casting.*
17. In a *permanent-mold* process, the mold may be opened to remove the molded

part. The mold can then be closed and used again. In some cases the mold is made so the molded part can drop out.

18. This is a prestressed concrete-beam mold. The cast part can be removed easily from the mold, because it is open on the top.
19. These permanent molds are slightly different. They are completely enclosed and must be opened to remove the molded tire.
20. *Die casting* of metals is highly automated. The liquid material is poured into a chamber and forced (*under pressure*) into the cavity of a closed mold or die. When the casting hardens, the mold is opened. The molded part is ejected (thrown out). The mold is then ready to go through the same cycle again.
21. This worker is holding a retainer ring for an aircraft rocket launcher. The ring was made in the die-casting machine behind the worker.
22. The *injection molding* of plastics is also highly automated. A granular plastic is forced through a heater that changes it into a liquid before it enters the mold. When the material in the mold has hardened, the mold is opened and the molded part is ejected. Then the mold is closed and the cycle repeats itself.
23. This worker is holding a plastic component that was produced by this injection-molding machine. Notice the hopper where the plastic granules enter the machine.
24. *Centrifugal casting* is done by taking a permanent mold, pouring in a liquid material, closing the mold, and then rotating it to force the material against the cavity walls.
25. This centrifugal casting machine with its permanent crucible is designed for small, delicate jewelry work. Notice how the rotating action forces the molten material from the crucible into the mold cavity.
26. *Slush casting* involves pouring *slip* into a mold that will absorb water. The mold material draws water, forming a hardened layer around the cavity walls. The remainder of the slip is then poured out. The hollow casting left in the mold is removed later.
27. This worker is filling a row of two-part lamp-base molds with slip from an overhead conduit. Some of the hollow lamp bases can be seen sitting on racks in the background.

    This filmstrip has shown you examples of each of these casting or molding processes: *One-shot* molding processes are *sand casting, shell-mold casting, investment casting,* and *"on site" placing of concrete. Permanent-mold* processes are *permanent-mold casting, die casting, injection molding, centrifugal casting* and *slush casting.*
28. Credits.

Laboratory Activity (30)

Today, the students are to prepare a sand-cement mixture and manufacture four concrete bricks, using a *permanent-mold* process.

1. Students will work in their groups of 5.
2. They are to work on plastic dropcloth or newspapers placed on top of the bench.
3. For this activity 30 minutes has been scheduled, so students can thoroughly clean their equipment and remove any splattered concrete from the floor.
4. If time permits, discuss the laboratory questions after students have answered them.

Safety Precautions

1. Students should avoid prolonged contact of cement on their hands.
2. To avoid clogging school sinks with waste concrete, use a rinse barrel such as a plastic garbage can.

Homework

None

Note

1. Remind students that discussion of important points of today's filmstrip will be held tomorrow.
2. Small holes may be drilled in 2" x 4" top of brick mold to aid removal of finished brick by breaking suction.
3. The teacher may want to use the flower pot option in place of brick for Assign-

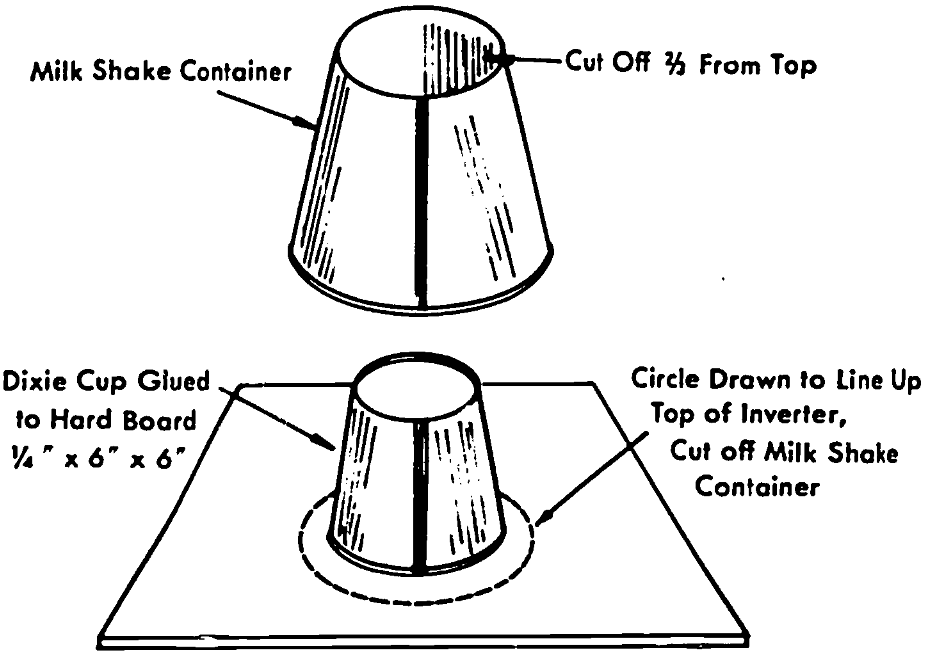


Fig. 96-1. Flower Pot Option

ment 99 (optional). See Fig. 96-1. If so, be sure to prepare bottom boards with glued dixie cups in advance.

Answers for Laboratory Manual

1. No.
2. Because the same mold is used again and again.

ASSIGNMENT 97, ACTIVITY 55B

Casting or Molding

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Using a filmstrip on casting or molding processes:
   a. Describe the casting or molding process.
   b. Describe the differences between one-shot and permanent molding processes.
   c. Name the major one-shot molding processes and give examples of products produced by one-shot molds.
   d. Name the major permanent molding processes and give examples of products produced by permanent molds.
   e. Describe two ways that a mold may be designed to permit removing the molded part and give examples of products produced by open and upset molds.

Laboratory Activity

2. Given a discussion and a demonstration covering casting or molding, and questions on the major concepts involved, demonstrate knowledge of the materials covered by successfully answering 80% of the questions in the Laboratory Manual.

Time Schedule

5 Overview
10 Discussion
25 Demonstration
5 Laboratory Activity

Equipment and Supplies for Demonstration

Equipment

1 trowel
1 foundry riddle
1 bench rammer
1 6" x 8" foundry flask
1 8" x 10" molding board
1 8" x 10" bottom board
1 spoon and gate cutter
1 4-qt. bucket
1 molder's bellow
1 pr. tweezers
1 pc. ½" x ½" x 12" cold-rolled steel (strike bar)
1 pc. 2" x 3" tin plate, bent U-shaped (for cutting pouring basin)
1 ½" dia. x 6" mild steel rod (rapping pin)

Supplies

15 lb. molding sand, *or* Petro Bond
½ lb. nonsilica parting dust in cloth bag, *or* talcum powder
1 4' x 4' heavy plastic dropcloth
5 pcs. patterns, mallet head 1" dowel 2" long
1 No. 8, 2½" wood screws
1 pc. ⅜" polyethylene plastic tubing, 6" long, split lengthwise as pattern for gating channels

Overview (5)

1. Yesterday you saw a filmstrip on the major concepts of a set of forming processes called *casting or molding*. Then you had an opportunity to cast a part using the permanent mold process.
2. Today we want to discuss the major ideas presented yesterday. Then I will demonstrate to you how to ram up a sand mold.
3. You will be asked to answer questions about the concepts presented in the filmstrip and answer questions in the Laboratory Manual.

Discussion (10)

Guide the discussion so that the following points are reinforced:

1. What *happens* in a casting or molding process? (Usually a liquid, or material that flows like a liquid, is poured into a hollow mold or cavity. The hole or cavity in the mold has the size and shape of the wanted component.)
2. What is the *difference* between (1) a one-shot molding process and (2) a permanent-mold process? (In one-shot molding the mold is destroyed after the first use. In the other case the mold is reusable.)
3. What are the *major* one-shot molding processes? (Sand casting, shell-mold casting, investment casting, and other variations such as the on-site placing of concrete.)
4. What *products in your laboratory* might have been made by the one-shot mold process? (Vises, machine bases, anvil base.)
5. What is *involved* in a permanent-mold casting? (Pouring a liquid or powdered material into a mold, later removing the molded part, and then using the mold again.)
6. What are the *major* permanent-mold processes? (Permanent-mold casting, die casting, injection molding, and variations such as centrifugal casting and slush casting.)
7. In what *two ways can the mold be designed to permit removing* the molded part? (It can be made to open. It can be made to change position, so the part will drop out.)
8. Name some products that are formed in molds that *open*. (Tires, glass bottles, plastic containers.)
9. Name several products formed in molds that are *upset*, so the molded part will "drop out." (Bread, metal pigs or ingots, some ice cubes.)

Demonstration (25)

Today I will demonstrate what is called "ramming up" a one-shot mold. Follow the directions step by step in your Laboratory Manual, ACTIVITY 55C and D. You will be doing these same operations in the next activity. NOTE: In the script that follows, the name of each special piece of equipment and material is italicized. *See Laboratory Manual, Figs. 55C - 1 to 17.*

Preparing to Work

1. Spread the plastic dropcloth over your work area so that it will be easier to clean up spilled sand.
2. Fill the bucket with *molding sand* and carry it to your work area.

Ramming the Flask

3. Place the *flask* upside down on the *molding board.*
4. Arrange five *patterns* inside the flask with screw holes down. Refer to Fig. 55C-1.
5. Cut and place five split tubings inside the flask. Refer to Fig. 55C-2.
6. Shake some parting compound over the patterns and split tubing. Refer to Fig. 55C-3.
7. Using the *riddle,* sift at least one inch of sand over the patterns. If you use *Petro Bond* sand, it is not necessary to use the riddle. Refer to Fig. 55C-4.
8. Press the sand around the patterns with your fingers. Refer to Fig. 55C-5.
9. Fill flask with sand until it is piled above sides of flask. Refer to Fig. 55C-6.
10. Use a *bench rammer* to ram the sand into the flask. Refer to Fig. 55C-7.
11. Smooth the top of the flask with a *strike bar.* Refer to Fig. 55C-8.
12. Place the *bottom board* on top of the flask and *upset* the flask. Refer to Fig. 55C-9.
13. Remove the molding board.
14. Use a *trowel* to make the surface smooth. Refer to Fig. 55C-10.
15. Blow off all loose sand with a *bellows.* Refer to Fig. 55C-11.
16. Use a pair of tweezers to lift the half-tubings from the flask. Refer to Fig. 55C-12.
17. Cut pouring basin. Refer to Fig. 55C-13.

Removing the Pattern

18. Twist the wood screw into the hole in the bottom of one pattern.
19. Use a small *rapping pin* to tap firmly all around the edge of the pattern. Refer to Fig. 55C-14.
20. Slowly and carefully lift the pattern from the flask. Refer to Fig. 55C-15.
21. Repeat Steps 18-20 for each pattern.
22. Repair all damaged areas with a spoon. Refer to Fig. 55C-16.
23. Remove castings from the flask. Refer to Fig. 55C-17.
24. Blow all loose sand from the flask and out of the mold cavities with a bellows.

Laboratory Activity (5)

Students will answer five questions about casting or molding.

1. Have students open their Laboratory Manuals and answer the questions.
2. Discuss the answers if time permits.

Safety Precautions

Be careful not to blow sand into students' eyes with bellows.

Homework

None

Note

1. Teacher may use Laboratory Activity time to clean up demonstration area while students are answering questions.
2. Teacher should precut styrene plastic sheet to 6" x 6" size for use in Assignment 100.

Answers for Laboratory Manual

1. Destroyed
2. Reused
3. a. Sand casting
   b. Shell-mold casting
   c. Investment casting
4. a. Permanent-mold casting
   b. Die casting
   c. Injection molding
5. a. Answers vary
   b. Answers vary
   c. Answers vary

ASSIGNMENT 98, ACTIVITY 55C

ASSIGNMENT 99, ACTIVITY 55D (OPTIONAL)

Casting or Molding

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Using a pattern and the necessary equipment and supplies, ram a mold for sand casting.
2. Given a demonstration by the teacher on the pouring of a sand mold, point out why sand casting is a one-shot molding process.

Time Schedule

Assignment 98
5 Overview
40 Laboratory Activity
Assignment 99 (Optional)
45 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 trowel
1 foundry riddle
1 bench hammer
1 6" x 8" foundry flask
1 8" x 10" molding board
1 8" x 10" bottom board
1 spoon and gate cutter
1 pc. 2" x 3" tin plate, bent U-shaped (for cutting pouring basin)
1 4-qt. bucket
1 molder's bellow (per class)
1 pr. tweezers
1 ½" dia. x 6" mild steel rod (rapping pin)
1 pc. ½" x ½" x 12" cold-rolled steel (strike bar)

Pouring is to be done by the teacher.

Supplies (Group of 5)

15 lbs. molding sand or Petro Bond
½ lb. nonsilica parting dust in cloth bag or talcum powder
1 4' x 4' heavy plastic dropcloth
5 pcs. patterns, for mallet head 1" dowel 2" long
1 No. 8, 2½" wood screw
1 pc. ⅜" polyethylene plastic tubing, 6" long, split lengthwise as pattern for gating channels
3½ lb. type metal
½ oz. AZ Flux

Equipment (Per class)

5 rammed sand molds, by students
1 crucible furnace *or* bench furnace
1 crucible *or* ladle
1 pr. crucible tongs
1 ingot mold
2 face shields
2 pr. asbestos gloves
1 skimmer

Overview (5)

1. Yesterday you discussed the major concepts of casting and molding. Then you saw a demonstration of ramming up a *one-shot* mold. Today you will apply some of the ideas that you have learned concerning casting and molding in forming a part or component.
2. Your group will ram up a sand mold to make the castings for five mallet heads.
3. For safety reasons, the teacher will do the actual pouring of the mold for you to observe.
4. The completed castings will be stored for later use in producing a mallet.

Laboratory Activity (40)

The students are to make molds for a *one-shot* molding process. The teacher will pour the hot metal. Emphasize that sand molds are destroyed when the casting is removed.

1. Students are to work in regular groups of five.
2. They are to ram their molds over a heavy plastic dropcloth placed on top of their workbench.
3. At the end of each period, unfinished and unpoured sand molds *must be destroyed* so the next class may use the flasks. NOTE: If the laboratory activity is not completed in one class period, it might be advantageous to have the fol-

lowing class continue on from the point at which the previous class finished.

4. If you were not able to ram up and pour enough mallet heads in ACTIVITY 55C, then Optional ACTIVITY 55D, will need to be used as a continuation of ACTIVIITY 55C.

Safety Precautions

1. Students observing pouring wear *safety glasses.*
2. Wear *safety glasses* and *asbestos gloves* when pouring molten metal.
3. Metal does *not* change color when turning from a solid to a liquid state.
4. Water on molten metal causes it to *splatter.*
5. Be careful not to blow sand into the face or *eyes* of others or yourself with bellows.

Homework

Reading 51, *Compressing or Stretching*

Note

1. For safety reasons, the teacher is to pour the molds. One or two students might be trained to help.
2. Try your melting equipment ahead of time so you will know how much time to allow for melting the material.
3. A crucible and a crucible furnace are recommended. However, a bench furnace with a melting pot and ladle might be used.

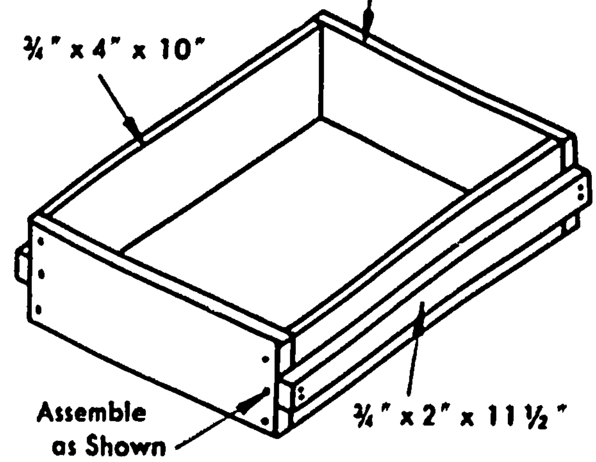


Fig. 98-1. Flask

4. Small-size flasks are recommended, due to the time needed for ramming the molds.
5. The flasks can be made from wood if no others are available. See Fig. 98-1.
6. If you have insufficient time to complete this laboratory activity because of inadequate equipment or any other reason, you may use Optional ACTIVITY 55D.
7. Store these castings for use in Assignment 121.
8. Pour a few extra castings to allow for the possibility of new students enrolling between this assignment and Assignment 121.

ASSIGNMENT 100, ACTIVITY 56A
READING 51

Compressing or Stretching

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using the information about compressing and stretching processes:
   a. Identify products around the home that have been formed by compressing and stretching.
   b. State how makers of cookies (or spaghetti) use compressing or stretching processes in the manufacture of these products.

Discussion

2. Given a presentation on compressing and stretching:
   a. Name the major categories of compressing or stretching processes.
   b. Name the forces involved in forging, rolling, and compression molding.
   c. Name a forming process in which both stretching and compressing occur.
   d. Name the forces which occur in such drawing processes as vacuum forming and stretch forming.
   e. Give examples of forming by forging, rolling, compression molding, bending, and drawing.

Laboratory Activity

3. Given a demonstration on vacuum forming and compression molding:
   a. Vacuum-form an object as shown in Laboratory Manual.
   b. Perform an operation of compressing some material in a mold under the pressure of a vise.

Time Schedule

5 Overview
15 Presentation-Demonstration
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

Equipment

1 infrared heat lamp mounted on a vertical support to permit height adjustment
1 pc. hardboard
1 pr. gloves

Supplies

1 Transparency 100, *Major Categories of Compressing and Stretching*
1 pc. duplicator paper
1 pc. 1/16" x 2" x 2" acrylic plastic
1 6" colored balloon
1 clear plastic bottle, 1 pt. to 1 qt. size with several 1/8" dia. holes drilled in the larger sections

Equipment and Supplies for Laboratory Activity

Equipment (Class)

2 vacuum-forming boxes
1 vacuum sweeper w/hose
2 250-watt infrared heat lamps
2 outdoor floodlight sockets, mounted on upright stands
4 No. 3, 2½" bulldog clips

Equipment (Group of 5)

1 compression-molding kit No. 100
1 vise *and vise guards*

Supplies (Group of 5)

5 pieces 6" x 6", .020-gage styrene plastic sheeting, .010-gage if available
1 cup fine woodchips *or* sawdust

Overview (5)

1. You have been studying and participating in casting and molding activities. Today, we will introduce two other material-forming practices, compressing and stretching.
2. These points were emphasized in the text reading:
   a. In elastic deformation, the new shape is not permanent.
   b. In plastic deformation, when the force causing the deformation is released, the new shape is retained.
3. You will be asked to name the major categories of the compressing and stretching processes.

4. In today's activity you will perform both compression-molding and vacuum-forming operations.

Presentation - Demonstration (15)

Today's lesson concerns five major categories or groups of compressing and stretching processes.

1. Show Transparency 100, *Major Categories of Compressing and Stretching.* The major categories of compressing and stretching processes are: forging, rolling, compression molding, bending, and drawing.
2. Forging, rolling, and compression-molding processes use compressive or "squeezing together" forces for shaping the component. You will forge a piece of steel in the next activity. Last semester you roll-formed lead to form standard stock. Today you will do some compression molding. No binder is necessary in today's compression molding, though often a binder is used.
3. Both compressing and stretching occur when components are formed by bending and drawing processes. You will see this today as I demonstrate bending a piece of plastic.
   a. Plastic should be notched as shown in Fig. 100-1.
   b. Place the plastic on the hardboard platform under the heat lamp. The lamp should be 3" from the plastic. See Fig. 100-2.
   c. Fold a sheet of notebook paper eight times to form a pad spacer when you bend your plastic.
   d. When your plastic is hot enough to bend readily, fold the plastic double as follows:
      (1) One end of the bend line should be between the saw kerfs in the edge of the plastic.
      (2) The folded paper should be placed between the folded surfaces of your plastic.
   e. Point out that the saw kerfs plainly show that the outside surface at the bend is stretched and the inside surface is compressed. Allow students to observe the bent piece after it has cooled.
   f. Point out that this same compressing and stretching occurs regardless of material.

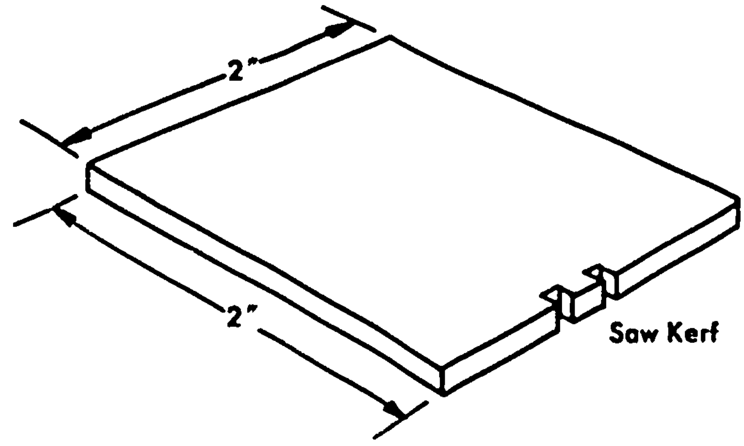


Fig. 100-1. Plastic Square

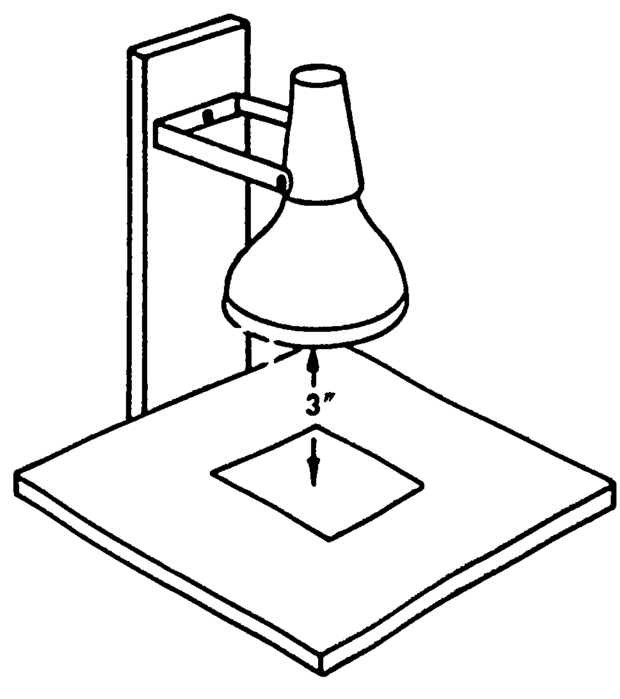


Fig. 100-2. Heat Lamp

4. Stretching or tension forces are used for forming the component in drawing processes such as vacuum forming, stretch forming, and blow molding. If you inflate a balloon inside a plastic bottle, the balloon takes the shape of the bottle. NOTE: Holes must be drilled in the bottom of the plastic bottle to release air as the balloon fills the cavity. This is what happens in a blow-molding process. Demonstrate by inflating a balloon inside a clear plastic bottle. Point out that bottles are *blow-molded.*
5. You will do some *vacuum forming* in today's activity. Drawing usually involves stretching a material over a die to give it a certain shape. Drawing is sometimes

called *stamping*. You did some draw forming on a piece of aluminum during the first activity on materials-forming practices.

Discussion (5)

1. What are the *major categories of compressing and stretching processes?* (Forging, rolling, compression-molding, bending, and drawing.)
2. Forging, rolling, and compression-molding are *examples of forming* by what type of forces? (Compressive forces.)
3. *Name the forming processes* where both *compressing* and *stretching* occur. (Bending and drawing processes.)
4. *What type of forces occur in drawing processes* such as vacuum forming and stretch forming? (Stretching or tension forces.)
5. Give an example of a product formed by each kind of process:
   a. Forging (A screwdriver blade or chisel.)
   b. Rolling (Structural channels, "I" beams, corrugated sheet metal.)
   c. Compression molding (Plastic plates, chipboard, aspirin tablets.)
   d. Bending (Coat hanger, baking pan, mailing envelope.)
   e. Drawing (Draw-formed automobile bodies, draw-formed automobile hub caps, wire, and vacuum-formed plastic packages.)

Laboratory Activity (20)

Student will do both vacuum forming and compression molding in today's activity.

1. Briefly demonstrate vacuum forming.
2. Briefly demonstrate compression molding. Point out that no binder is necessary.
3. Assign two groups to begin vacuum forming.
4. Three groups should be performing Problem 2 on compression-molding. Rotate the groups as they finish.

Safety Precautions

1. Wear goggles in the area of the heat lamp.
2. Do not touch heat lamps.

Homework

None

Answers for Laboratory Manual

1. Compression
2. Heat

Note

1. Be sure vise jaw guards are used with the compression-mold kit.
2. Obtain sawdust from inside base of table saw.
3. Look ahead to Assignment 103. See Fig. 103-1 to be built by teacher or borrowed from science department.

ASSIGNMENT 101, 102
ACTIVITY 56B, C

Compressing or Stretching

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation on compressing or stretching material, describe what is meant by malleable, ductile, and plastic material.
2. Given a demonstration on compressing metal by forging:
   a. Explain the basic difference between a squeezing force and a hammering force.
   b. Name a process used to form heads on nails and other similar fasteners.

Laboratory Activity

3. Given a demonstration on forging and the necessary equipment and supplies:
   a. Forge a screwdriver blade.
   b. File and polish the blade to shape.

Time Schedule

Assignment 101
5 Overview
15 Presentation - Demonstration
5 Discussion
20 Laboratory Activity

Assignment 102
45 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

Demonstration A, Cold Forging

Equipment

1 overhead projector w/screen
1 13 oz. ball peen hammer
1 vise
1 rivet jig No. 101
1 C-clamp

Supplies

1 Transparency 101, *Changing the Shape of Solid Materials*
2 pcs. 1/8" dia. x 5/8" soft aluminum wire

Demonstration B, Hot Forging

Equipment

1 anvil *or* equivalent
1 propane torch w/blowtorch head
1 spark lighter
1 13 oz. ball peen hammer
1 pr. vise grips, wrench, *or* multigroove pliers
1 10" smooth mill file
1 pr. asbestos *or* welding gloves
1 pr. safety glasses
1 set vise jaw covers

Supplies

1 pc. 3/16" dia. x 6" drill rod

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 anvil *or* equivalent
1 propane torch w/blowtorch head
2 13 oz. ball peen hammers
2 prs. vise grips (wrenches) *or* multigroove pliers
3 10" smooth mill files
2 prs. asbestos *or* welding gloves
5 prs. safety glasses
1 set vise jaw covers

Supplies (Group of 5)

5 pcs. 3/16" dia. x 6" drill rod
10" masking tape

Note

Teacher should control spark lighter for each propane torch.

Overview (5)

1. Today we will continue to compress and stretch material, but instead of forming sheet metal and plastic we will shape solid steel by heating and hammering.
2. Today the terms "ductile," "plastic," and "malleable" will be explained and discussed.
3. I will show you how rivet heads are made by a technique called "cold heading." I will also demonstrate how to change the shape of metal by heat forging.
4. You will be asked questions about the difference between a squeezing force and a hammering force and be expected to give examples of products made by hammering.

5. In the laboratory activity you will each forge your own screwdriver blade and file it to shape. Later you will condition the blade to make it stronger.

Presentation - Demonstration (15)

In compressing or stretching processes, solid material usually is given a desired shape without melting it. The material must have a special property or characteristic to make it suitable for one of these processes.

1. Show Transparency 101, *Changing the Shape of Solid Material.* If a solid material is to be forced into a different shape, it must not be brittle. If it is hard and brittle, it will fracture or break rather than change its shape.
2. For compressing or stretching processes, the material must yield or "give" without breaking.
3. If the shape of a solid material can be changed by hammering or rolling, the material is *malleable.* A *mallet* is a hammer. and *malleable* means "hammerable." Gold, lead, and copper, for example, are malleable materials.
4. *Forging* means using pressure to give material a desired shape. Forging processes are done either with a repeated *hammering* force or with a continuous *squeezing* force.
5. If the shape of a solid material can be changed by stretching or pulling, the material is *ductile.* Copper drawn into wire is an example of a ductile material. Some materials are both malleable and ductile.
6. Materials that can be squeezed into a new shape are *plastic.* Examples are clay and toothpaste.
7. Many materials become more malleable, or ductile, or plastic, as they are heated.
8. Some metals can be forged at room temperature; others are heated before-hand. Today I will demonstrate both cold forging and hot forging.

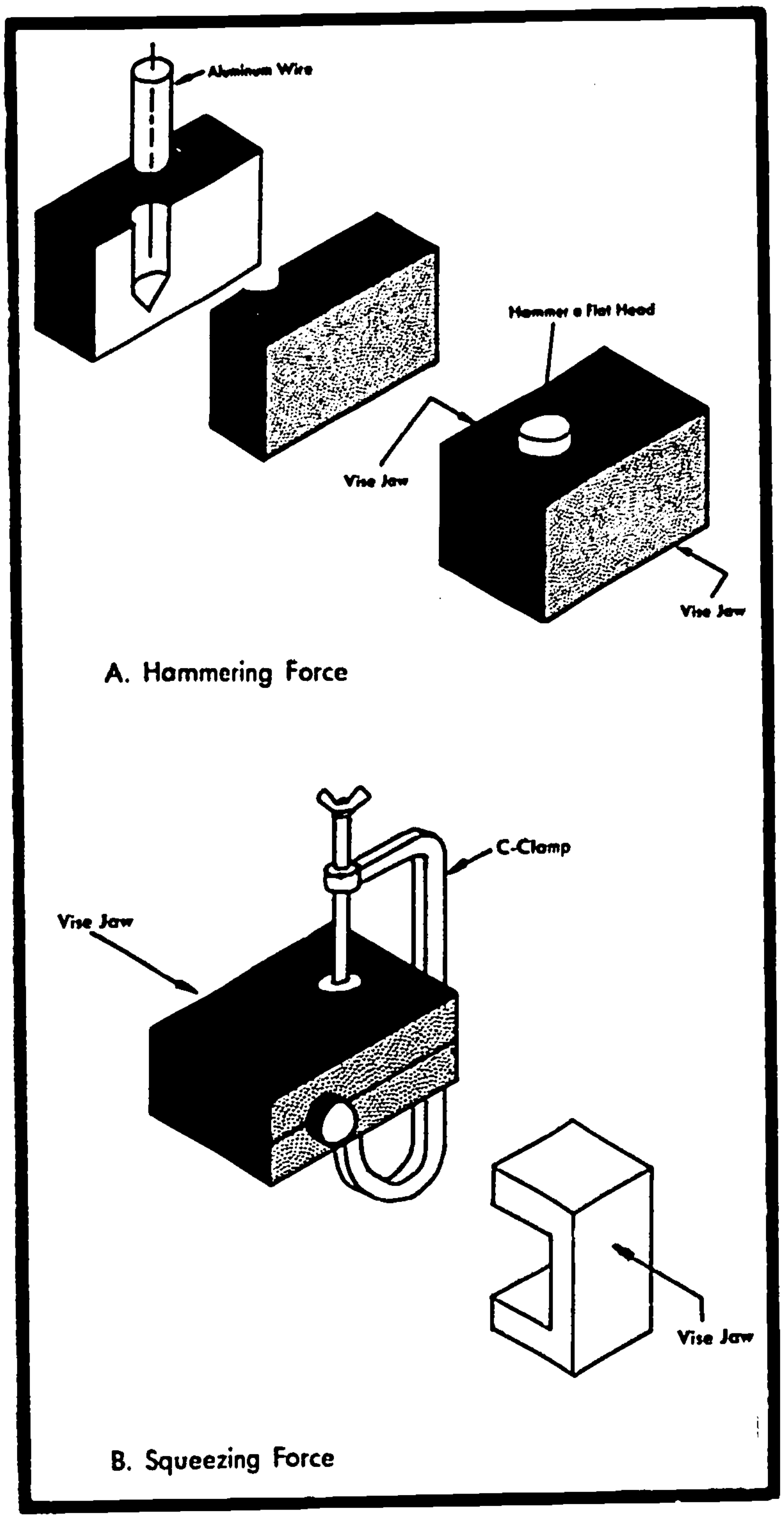


Fig. 101-1. Cold Forging

Demonstration A, Cold Forging

1. Demonstrate how an aluminum rivet head can be formed by a hammering force. See Fig. 101A.
2. Demonstrate how an aluminum rivet head can be formed by a squeezing force. See Fig. 101B.
3. The heads on nails and similar fasteners are made by a process called *cold heading,* which is very similar to these examples.

Demonstration B, Hot Forging

1. In the laboratory today, students will forge a blade for a screwdriver.
2. Demonstrate the forging technique used to produce a screwdriver blade.

Discussion (5)

Guide the discussion so these points are reinforced.

1. What is a *malleable* material? (One that

can be forced into a different shape by hammering or by rolling. Example: lead.)

2. What is a *ductile* material? (One that can be forced or drawn into a different shape by stretching or pulling. However, it sometimes means a material that can be given a new shape by a hammering or squeezing process. Example: wire.)
3. What is a *plastic* material? (One that can be forced or drawn into a different shape by squeezing. Example: modeling clay.)

Note

The word "plastic" has at least three other frequently used meanings.

a. It sometimes refers to any material that can be shaped by hammering or stretching, as well as by squeezing.
b. It may refer to any one of a group of special organic compounds (such as vinyl, styrene, or melamine) that can be molded, extruded, drawn, etc.
c. It may refer to a whole class of organic compounds (including vinyl and the others) that are closely related in their chemical makeup.

4. What is forging? (Using pressure to shape a material. Example: wrenches.)
5. What is the basic difference between a squeezing force and a hammering force? (Squeezing is continuous; hammering is a repeated force.)
6. Name a process for forming heads on nails and similar fasteners. (Cold-heading.)

Laboratory Activity 101 (20)

Each student will heat a piece of drill rod and forge it into a screwdriver blade.

1. Students will work in their regular groups of five.
2. Distribute the equipment and supplies.
3. Heat one end of the $\frac{3}{16}''$ drill rod.
4. Forge the heated end on an anvil, using a ball peen hammer to form a blade.
5. When screwdriver blade is forged, students should file and polish the blade to shape.

Laboratory Activity 102 (45)

Continuation of compressing and stretching activity.

Safety Precautions

1. Wear safety goggles.
2. Wear asbestos or welding gloves.
3. Use caution when working with a propane torch.

Homework

Reading 52, *Conditioning Materials*

Answers for Laboratory Manual

1. Heating
2. Hammering
3. File

ASSIGNMENT 103, ACTIVITY 57A
READING 52

Conditioning Material

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using information about conditioning material:
   a. Identify products around the home that have been conditioned by heat treating, mechanical deformation, and by chemical reaction.
   b. Identify what kinds of chemical reactions go on in the baking of bread dough and in the canning of fruits and vegetables.

Discussion

2. Using a filmstrip presentation:
   a. Define conditioning.
   b. Give two reasons for conditioning a material.
   c. Name three major conditioning processes.
3. Using the term *thermal conditioning,* name an example.
4. Using the example of a *hard-boiled egg,* identify the kind of conditioning process it has undergone.
5. Using an example of a *metal bowl formed by spinning,* identify the kind of conditioning process which occurs during the spinning operation.

Laboratory Activity

6. Using a suitable mold and a mixture of casting resin and hardener, pour the mixture into the mold to form a screwdriver handle.

Time Schedule

5 Overview
15 Filmstrip Presentation
10 Discussion
15 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation

Equipment

1 35mm. filmstrip projector w/screen

Supplies

1 Filmstrip 103, *Conditioning Material*

Equipment and Supplies for Laboratory Activity

Equipment (Per class)

1 8 oz. measuring cup
1 test tube rack *or* substitute, to hold 25 culture tubes. NOTE: See Fig. 103-1 for making test tube rack.
5 felt tipped pens, fine point

Supplies (Group of 5)

5 20 x 150 mm. disposable glass culture tubes, available from hospital supply dealers
1 pc. masking tape, approx. 10″
37½ oz. clear plastic resin for 25 students: each screwdriver handle will use 1½ oz.
½ oz. bottle transparent dyes — assorted colors: NOTE: Each ½ oz. color will be enough for all classes.
quantity of hardener, catalyst

Overview (5)

1. Yesterday you formed a screwdriver blade by compressing and stretching. Today you are going to learn how to condition materials.
2. In the reading assignment you learned that the main reasons for material conditioning are: (a) to make the material easier to work during processing, and (b) to give the final product a particular quality or desired characteristic.
3. Most conditioning processes can be divided into three general types: (a) thermal conditioning, (b) conditioning during mechanical deformation, and (c) chemical reaction.
4. In today's filmstrip you will see several ways of conditioning a material. The filmstrip will show the major processes, with several industrial examples.
5. In your Laboratory Activity you will cast your own screwdriver handle using a permanent mold.

198

Filmstrip Presentation (15)

Script for Filmstrip No. 103 —
25 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Conditioning Material*
5. Conditioning a material changes its internal structure or form. Usually there is no visible, external effect.
6. Conditioning processes are performed primarily for one of two reasons: (1) to make the material easier to work during processing or (2) to give the final product a particular quality or desired characteristic.
7. The major categories of conditioning processes are: *thermal conditioning, chemical* reaction, and *physical* or mechanical deformation processes.
8. *Thermal conditioning* requires the addition and the withdrawal of heat in various amounts, sequences, and lengths of time.
9. Heat-treating processes are the most common types of thermal conditioning. This frame shows gear teeth being heated in a special gas mixture and cooled with a liquid solution. The process is called *case hardening.*
10. The *quenching* process shown here is used for hardening metal parts. The parts are heated to a moderately high temperature and then plunged into oil or water.
11. *Annealing* furnaces are used to heat metal to a uniform temperature and then let it cool slowly. This makes the metal softer and less brittle so that cold-working operations can be performed more efficiently.
12. A *chemical* reaction rearranges the material's atoms so that a chemically different substance is formed. Sometimes heat is required to aid the process. When a raw egg is placed in boiling water for twenty minutes, the internal material is converted into a different substance. This is a chemical reaction caused by heating.
13. The vats you see are used to tan skins and chemically treat animal furs and raw pelts. Before any animal skin is transformed into leather, it must be chemically treated.
14. Here, clay components are being placed in "saggers" before they enter the firing process. The firing produces a chemical reaction.
15. You are looking at a circular pressurized oven, industrially known as an autoclave. A fiberglass sheet has been clamped to a permanent mold so that when the door is shut, heat and pressure will condition the material to take the shape of the permanent mold. The workmen are preparing a fiberglass canopy for a helicopter.
16. This electronically controlled tire-curing machine has just ejected cured tires from its molds. The cured tires will now be cooled while they are inflated, to temper the tire cord.
17. The electronic treater bar shown here aids in curing the coated substrate, the underlayer, passing between it and the roll. The material being rolled is transparent plastic.
18. *Physical or mechanical* deformation during the working of the material will affect its internal structure. Generally, the higher the working temperature, the less chance there is of distorting the material grains.
19. Sometimes the working of materials produces desirable internal changes. This frame shows the grain flow of a forged piece. Forging increases the part's strength.
20. *A metal-spinning process* tends to increase the material's hardness. For most purposes this hardness is not desirable.
21. The *magnetizing* of a screwdriver tip is a physical change.
22. Sometimes the moisture content of a material is changed. This log is steamed to aid in the cutting of veneer.
23. In some processes, the moisture content of a material is lowered. This lumber is being removed from the kiln following a drying process.
24. This filmstrip has shown you examples of each of the major material-conditioning processes: thermal conditioning,

chemical reaction, and physical or mechanical deformation.
25. Credits.

Discussion (10)

Guide the discussion so that the following points will be reinforced.

1. What does *conditioning* a material mean? (Changing its internal structure or form, usually without any visible, external effects).
2. What are the two main reasons for conditioning a material? (To make the material easier to work during processing. To give the final product a particular quality or desired characteristic.)
3. Name the three major categories of conditioning processes. (Thermal conditioning, chemical reaction, and physical or mechanical deformation processes.)
4. What happens in a chemical reaction? (The material's atoms are rearranged so that a chemically different substance is formed.)
5. What does thermal conditioning mean? (A physical change brought about by heat.)
6. What type of conditioning has a hard-boiled egg undergone? (Chemical reaction.)
7. What type of conditioning takes place when a bowl is formed by spinning? (Conditioning from mechanical deformation.)

Laboratory Activity (15)

Each student will cast a handle using a casting resin and hardener. The chemical reaction conditioning process is represented in the casting of screwdriver handles.

1. Each student is to print his name on a small piece of masking tape, and wrap the tape to a glass test tube 4¼″ up from the closed end.
2. Have each student pour the conditioned resin into his own test tube, up to the 4¼″ mark. You will need approximately 1½ oz. of resin for each test tube, or 37½ oz. for 25 test tubes. Tint or dye should be used according to package directions. Follow manufacturer's directions for using hardener.

   NOTE: Mix resin slowly. Test tube should be slightly tilted when pouring so resin will not trap air bubbles.
3. Store the filled mold in test tube rack.

Safety Precautions

1. The teacher should add the hardener to the plastic resin and mix them.
2. The teacher should add dye color, if desired.
3. Be sure that the room is as well-ventilated as possible.
4. Students should wash hands immediately if they get resin on them.

Homework

None

Note

1. See Fig. 103-1 for suggested rack, to be built by the teacher or borrowed from the science department.
2. Suggestion: use a nonfracture additive when pouring resin and hardener.

Answers for Laboratory Manual

1. Yes
2. Conditioning
3. Chemical
4. Yes
5. Answers will vary
6. Catalyst

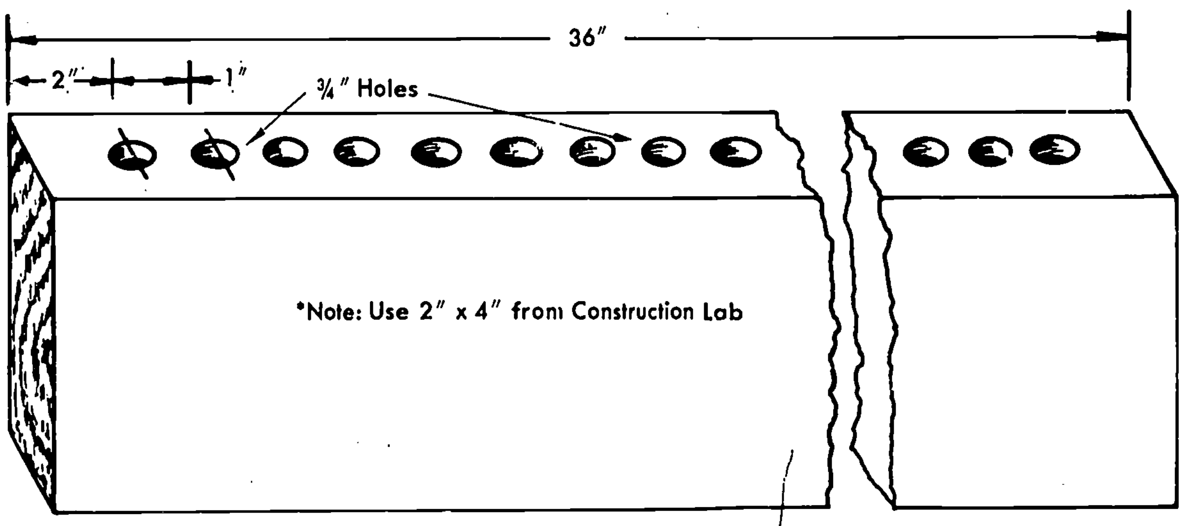


Fig. 103-1. Test-Tube Rack, Teacher Built (Optional)

ASSIGNMENT 104, ACTIVITY 57B

Conditioning Material

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation - demonstration on thermal conditioning, explain or describe:
   a. Why the screwdriver blade needs conditioning.
   b. The procedure for conditioning the screwdriver blade.
   c. The effect of quenching and hardening by metal deformation.

Laboratory Activity

2. Given a demonstration and the necessary equipment and supplies, thermal-condition a screwdriver blade by heat treating and quenching.

Time Schedule

5 Overview
10 Presentation - Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

The teacher will use the equipment and supplies needed for one group of students, plus the following to demonstrate the procedure they will follow.

Equipment

1 ball peen hammer, 8 oz.

Supplies

2 pcs. 4″ x 6″ aluminum *or* sheet copper, any gage

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 pr. vise grips *or* pliers
1 propane torch
1 can quenching oil, 6 oz.
1 pr. asbestos *or* welding gloves

Supplies (Per student)

1 hot forged and filed standard screwdriver blade from ACTIVITY 56B and C
1 pc. 3″ x 3″ wet or dry sandpaper, 200 grit
1 pc. fine emery cloth

Overview (5)

1. Yesterday you conditioned your screwdriver handle by mixing a resin with a catalyst, hardener, and poured it into a mold. This was a chemical reaction.
2. You have learned that the three kinds of processes for conditioning material are thermal conditioning, chemical reaction, and conditioning through mechanical deformation.
3. I will also demonstrate conditioning by mechanical deformation.
4. Today you will thermal-condition your screwdriver blade by heat treating.
5. In addition, you will polish your screwdriver blade.

Presentation - Demonstration (10)

1. To demonstrate conditioning by material deformation, demonstrate or have a student hammer one of two pieces of aluminum or copper. Bend each one of the two strips and report which one bent easier. The hammered aluminum or copper is obviously stiffer, due to the compression of metal molecules by hammering.
2. Forging the screwdriver blade has left it somewhat soft. To make it more useful, it needs to be hardened. The blade will be *conditioned* (made very hard) by heat-treating it.
3. Demonstrate heat-treating a screwdriver blade, following the Laboratory Manual procedure.
4. Review the procedures for lighting and extinguishing a propane torch, if necessary.

Discussion (5)

1. Why is the screwdriver blade conditioned? (The heat treating will harden the blade and make it more useful.)
2. How is the screwdriver blade conditioned? (By heating the blade to a cherry red color and dipping it into a quenching oil.)
3. Why is oil used as a quenching agent? (Carbon from the oil is transferred to screwdriver tip to make it harder.)

4. What physically happened to the aluminum metal after it was hammered? (Became harder due to mechanical deformation.)

Laboratory Activity (25)

1. Students will work in their regular groups.
2. See that all students observe precautions about handling *hot* material, the propane torch, and the wearing of safety goggles.
3. Assist students as necessary.
4. Students are to store the screwdriver blade for later use.

Safety Precautions

1. Wear safety glasses when heating metal.
2. Wear asbestos or welding gloves when heating metal.
3. Use pliers to handle hot metal.
4. Handle the propane torch carefully.
5. Make sure the room is properly ventilated.

Homework

Reading 57, *Making Assemblies or Finished Products*

Note

Make drilling fixture for ACTIVITY 58, Assignment 105, *Making Assemblies for Finished Products*.

Answers for Laboratory Manual

1. Thermal conditioning
2. Harden the blade
3. Oil
4. Cherry red

**ASSIGNMENT 105, ACTIVITY 58
READING 57**

Making Assemblies or Finished Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using information on making assemblies or finished products:
   a. Name some of the products around the home and identify which parts were assemblies in one stage of their manufacture but subassemblies in others.
   b. Name products in the classroom that have been combined by mixing, coating, bonding, and mechanical fastening.

Discussion

2. Using the school laboratory and its contents, identify those manufactured products which were produced by combining processes.
3. Using a filmstrip presentation, name four basic classifications of combining processes.
4. Using an example of a racing car, identify four parts and groups of parts as components, subassemblies, or a final assembly.

Laboratory Activity

5. Given a screwdriver handle, a screwdriver blade, and epoxy glue, perform sawing, filing, drilling, mixing, coating, and bonding operations to combine the three components to produce a final assembly or finished product.

Time Schedule

5 Overview
10 Filmstrip Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation

Equipment

1 filmstrip projector w/screen

Supplies

1 Filmstrip 105, *Making Assemblies or Finished Products*

Equipment and Supplies for Laboratory Activity

Equipment (Class)

3	mill files, 10″
1	miter box w/saw
1	drill press
1	3/16″ twist drill bit
1	screwdriver handle drilling fixture No. 105
1	3″ spring clamp
1	rack for holding screwdriver handles

Supplies (Group of 5)

3 pcs.	2″ x 2″ medium grit silicon carbide abrasive paper
1	4″ screwdriver handle, per student
1	6″ screwdriver blade, ACTIVITY 56B and C, per student
1 tube	epoxy resin (comes in a set)
1 tube	epoxy hardener (comes in a set)
5	3″ x 5″ paper cards *or* mixing plates
5	wooden sticks for mixing

Overview (5)

1. You have been exposed to various processes that manufacturers go through when making a product. Today you will learn how finished products are produced by combining components and subassemblies by cutting, drilling, mixing, coating, and bonding.
2. Today you will see a filmstrip entitled, *Making Assemblies or Finished Products.*
3. You will be asked to identify components, subassemblies, and final assemblies of products that are familiar to you.
4. In your laboratory activity you will saw, drill, and assemble your screwdriver handle and blade, using epoxy cement as a bonding agent.

Filmstrip Presentation (10)

In today's filmstrip, students will see examples of combining processes in each of the four basic groups.

Script for Filmstrip No. 105 — 29 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Making Assemblies or Finished Products*
5. Many completed products contain more than one *component* or part. Products with more than one component are not ready for use until the components have been assembled. The word *assembly* is used in two ways. It can refer to a process, or to a product that has been assembled.
6. These workers are carrying out the *process* of assembling bicycle frames.
7. When all the components of the bicycle have been put together, the resulting *product* can be called an assembly.
8. The words "assemble" and "combine" both mean "put together."
9. The basic groups or classes of combining processes used in manufacturing are mixing, coating, bonding, and mechanical fastening.
10. Some of the combining processes in each group or class will be studied in greater detail in succeeding units.
11. This technician is checking the consistency of a photographic chemical used in dark room developing. All the components for the emulsion (potassium halide, silver nitrate and gelatine) must be mixed.
12. This chair is being *coated* by spraying.
13. Arc welding is a *bonding* process. Welding holds two components together by *fusing* the two pieces of metal.
14. Thread serves as a *mechanical fastener* to combine pieces of cloth.
15. This telephone is a combination of 752 component parts. It would be very hard to assemble all of the parts at one time.
16. To make assembly easier, groups of parts which work together are assembled first. These groups are called *subassemblies.*

17. Eighty-five components are assembled to make the ringer subassembly of the telephone. Notice the components and the subassembly.
18. Sixty-nine components are combined to make the handset subassembly. Is a subassembly shown here? Yes, the cord is a subassembly of the handset subassembly.
19. Seventy-four components function together as a switch subassembly.
20. The most complex subassembly is the Touch-Tone® dial. There are 330 components in this subassembly
21. In order to function together, all these subassemblies must be combined.
22. Some of these components have been assembled into a subassembly, called a *circuit block.* This circuit block (along with other components contained in this group of parts) will be used to combine the other subassemblies.
23. These components are also used to combine subassemblies.
24. This is the final assembly. It is the finished product.
25. Keep in mind that the word "assembly" means "to combine or put together" and also refers to a product made by combining components.
26. There are four basic ways of combining components to produce an assembly: mixing, coating, bonding, and mechanical fastening.
27. To facilitate assembly, groups of components are first combined into subassemblies.
28. The finished product is the final assembly of subassemblies.
29. Manufacturing a subassembly or a final assembly may involve many specific processes.

Discussion (5)

1. What are two industrial meanings of the word "assembly"? (A process of putting together or combining. A combination of components.)
2. Name four manufactured products found in the laboratory that were produced by combining processes. (Any product that is a combination of two or more components.)
3. What are the four basic classes of combining processes? (Mixing, coating, bonding, and mechanical fastening.)
4. A racing car is a combination of many components. Identify each of the following as a component, a subassembly, or a final assembly.
   a. Steering wheel (component)
   b. Combined racing slick, tire, rim, and hub (subassembly)
   c. Gear shifter (component)
   d. Complete four-barrel carburetor (final assembly)
5. Can you think of a situation in which a high performance racing tire might be classified as a final assembly? (A manufacturer who produces and sells tires will regard them as the product or final assembly in his industry.)

Laboratory Activity (25)

Today's laboratory activity involves three separate processes in the final assembly of the screwdriver. Students will perform cutting, drilling, and bonding activities.

1. Students will work in their regular groups.
2. Caution students to read each step before attempting the tasks.
3. Observe students and provide help as needed.
4. Check the completed screwdrivers, as they are turned in, for correctness of assembly and student's name.
5. Arrange storage for the screwdrivers until the epoxy cures. NOTE: You may want to control the dispensing of epoxy glues.
6. Have students complete the Process Checklist (Screwdriver). The purpose of the checklist is to help the student recognize and reinforce the application of concepts to different situations and products.

Safety Precautions

1. Caution students *not* to get epoxy on their body or clothing. It is very hazardous if rubbed into the eyes.
2. The caps should be replaced on the tubes as soon as possible.
3. It is important *not* to switch caps. Hardener caps must not be put on resin tubes.
4. Wear safety goggles in drilling your screwdriver handle.
5. All files should have handles on them.
6. Do not let epoxy resin come in contact with your clothing or skin.
7. Keep room properly ventilated.

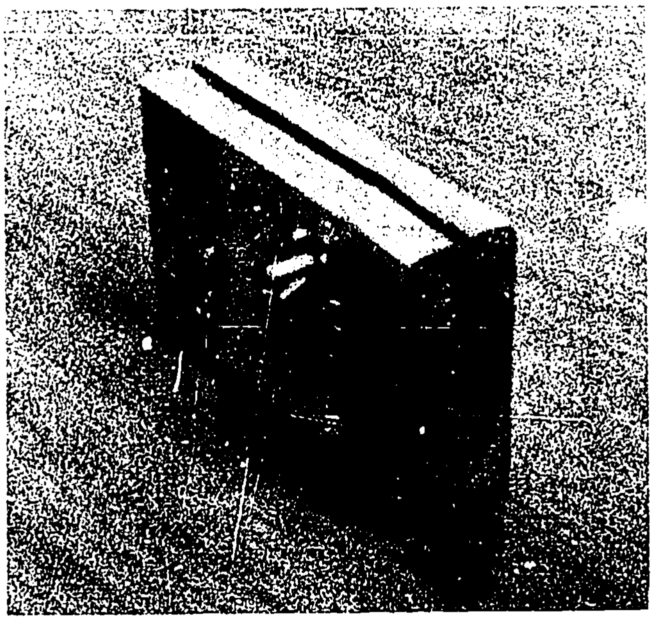


Fig. 105-1. New Design for Screwdriver Handle Drilling Fixture No. 105

Homework

If Optional Assignment 106 is used, assign a review of Readings 48-52 and 57. If Assignment 106 is not used, there is no homework.

Answers for Laboratory Manual

Figure 64-7, Processing Checklist (Screwdriver)

1. Permanent-mold casting (handle)
2. Forging (blade)
3. Chemical (handle), thermal (blade)
4. Polishing, sawing, filing, drilling (handle and blade)
7. Stirring (epoxy glue)
8. Adhesion (handle to blade)

ASSIGNMENT 106 (OPTIONAL)

Review No. 6

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the summaries of Readings 48-52 and 57, ask and answer questions about making components by forming or separating stock, material forming practice, casting or molding, compressing or stretching, conditioning materials, and making assemblies or finished products.

Time Schedule

45 Discussion *or* Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to do one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking and discussion.
3. Have each group of students get together and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker who is knowledgeable about forming industrial materials to talk to the class. Schedule the speaker for the first class period and tape record his talk so it can be played to your other classes.
5. Schedule a field trip to a casting and molding plant.
6. Show a film on making components.

Homework

None

ASSIGNMENT 107

Test No. 6

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 6, select the correct responses from a list of items related to concepts presented in Readings 48-52 and 57.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Place the test and answer sheet upside down on each student's desk.
4. At your command, have students turn over the tests and answer sheets.
5. Follow directions as given with the test.
6. Allow 35 minutes for completion; then collect test papers.
7. Review the test with students to provide feedback.

Homework

Reading 53, *Material Separating Practices*

Answers to Test No. 6

1. C	2. D	3. B	4. B	5. B	6. A	7. C	8. A	9. C
10. B	11. D	12. B	13. D	14. A	15. D	16. A	17. A	18. D
19. A	20. B	21. C	22. D	23. C	24. C	25. A	26. B	27. D
28. D	29. D	30. A	31. B	32. B	33. C	34. D	35. A	

ASSIGNMENT 108, ACTIVITY 59
READING 53

Material Separating Practices

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about material separating processes:
   a. Determine which separating process should be used to separate: sheet metal, sheet rubber, an iron casting, paper, and a block of stone.
   b. Determine which separating practice would be used to: cut glass for a window pane, burn a hole through metal, etch a design on glass or metal, cut a rough diamond, and rapidly eat a hole through metal.

Laboratory Activity

2. Using the necessary equipment and supplies, successfully make a metal I. D. tag.
3. Given five operations performed in this activity, identify the practices that each represents.

Time Schedule

5 Overview
10 Presentation
30 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 set Transparencies:
- 108-1. *Separating Materials by Shearing*
- 108-2. *Separating by Die-Punch Shearing*
- 108-3. *Separating by Chip Removing*
- 108-4. *Separating by Other Processes*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1	12″ steel rule
1	hand drill
1	1/8″ twist drill
1	10″ mill file, single cut
1	ball peen hammer, 8 oz.
1	center punch
1	3/8″ countersink
1	scratch awl
1 pr.	tin snips
3	X-acto® knives
4 prs.	scissors

Supplies (Group of 5)

1 pc.	20 ga. x 1″ x 5″ anodized aluminum (any color)
5	cotton swab sticks
1 tube	1½ oz. etching cream Etchall
10 pcs.	1″ x 1″ contact vinyl, plain light color

Overview (5)

1. You have read that the three basic groups or classes of separating processes are: (1) shearing, (2) chip removing, and (3) separating by other processes.
2. Today you will see transparencies that illustrate separating practices.
3. In the laboratory activity you will use these three separating practices to make an I. D. tag.
4. You will use the knowledge gained in this lesson to identify which practices the selected operations represent.

Presentation (10)

1. In today's lesson, "material" refers to solid materials, not to liquids or gases.
2. Show the Transparencies 108-1 to 108-4. The suggested script that follows may be read or paraphrased.
3. There are three basic ways to separate materials: by shearing; by chip removing; or by other processes.
4. Transparency 108-1, *Separating Materials by Shearing*:
   a. *Shearing* is basically a way of separating or dividing material with *no loss* of material for the purpose of dividing or imparting shape. By means of a mechanical advantage (usually a machine), a large force can be concentrated at a specific location along a sharp edge or blade. If the

material is softer and weaker than the cutting edge, the material will fail to separate along the cutting line.

b. This diagram shows the principle by which stock is separated by shearing. Notice that force is transmitted to the cutting edge in order to separate the material. In order for the workpiece to be separated, two requirements must be met:
   (1) The *force* must be strong enough to part the material.
   (2) The *cutting edge* must be sharp and tough enough to part the material.

c. After the material has been sheared, the combined length of the two pieces will match in length the original, unsheared piece. In a shearing operation, no material is lost along the cutting line.

5. Transparency 108-2, *Separating by Die-Punch Shearing.* Stock can be sheared to various shapes; therefore, the edges are not always straight lines. This particular diagram shows the use of a punch and die to shear circular holes in a piece of stock. Notice the die is stationary and is used to provide a mating surface for the punch. Force applied to the punch will shear stock to shape, over the cavity in the die.

6. Transparency 108-3, *Separating by Chip Removing*:

   a. The *chip removing* processes for separating materials involve removing unwanted material (in the form of chips, sawdust, or other fine bits) by using pressure on one or more cutting edges. The tool is harder and tougher than the material. The tool will remove chips of the material, dividing or shaping the workpiece (stock).

   Materials separate along a parting line. In chip removing processes some material is *lost* along this parting line.

   When material is separated to size by chip removing, the piece or pieces that remain are smaller than the original piece of stock because of the lost chips or fragments.

   b. Separating stock by chip removing involves the use of either a single-edge or a multiple-edge tool. The lathe is the most important type of machine that uses a single-edge cutting tool. This machine is used to reduce round stock to shape. The cutting tool of a lathe operates like a knife peeling an apple. When forced into the *rotating stock,* it will remove material from the workpiece in the form of chips, or continuous chips.

   c. Grinding is another way of removing chips; it uses a multiple-edge cutting tool. In grinding, the cutting edges are on the bits of abrasive material bonded together in the form of a wheel. When the *wheel is rotated* and the workpiece is forced against it, the abrasive material will remove stock from the workpiece in the form of very small chips.

   d. The twist drill is also classified as a multiple-edge chip removing tool. Notice the two cutting edges of the drill. When the drill is *rotated* and forced into the stock, it will remove stock in the form of chips, producing a circular hole in the workpiece.

   e. Chip removing may also be performed with a multiple-edge cutting tool. A saw is an example of a multiple-edge chip removing tool. The cutting tool has a linear movement.

7. Transparency 108-4, *Separating by Other Processes.* Advances in technology have placed unusual demands on the material-separating industries. New processes of separating materials have been developed to supply the demands placed upon the industry. Many of these separating processes use nonmechanical energy sources, such as chemical, electrical, or thermal energy. These processes may be broken down into four groups or categories: (a) thermal erosion, (b) chemical separating, (c) electrochemical separating, and (d) induced fracture separating.

   a. One of the most popular processes in the *thermal erosion* category is flame cutting. Flame cutting involves melting a little of the material along a cutting line, by burning a gas, usually acetylene. Once the material, usually a metal, reaches its melting point, oxygen is used to burn through and separate the material along a marked line. This exposes more material. The process goes on continuously, cutting away bits of unwanted material.

b. Etching is a *chemical separating* practice done by applying a blockout material to the part to protect sections not to be removed; then the piece is chemically treated to remove unwanted material.
c. A third category of new processes is *electrochemical separating.* The important process in this category is electrical discharge machining. Electrical discharge machining uses a tool connected to the negative terminal of a direct current power source. The material to be separated (called the "workpiece") is mounted close to the tool and is connected to the positive terminal of a direct current power source. Both the tool and the workpiece are submerged in a dielectric liquid such as kerosene. This liquid cools the workpiece and carries away the particles removed during machining. When the direct current is turned on, sparks from the tool will remove or erode material away from the workpiece. When the electrical discharge machining process has been completed, the hole or pattern in the workpiece will be exactly like the shape of the tool.
d. The last category of processes that fall into the classification of "separating by other processes" is *induced-fracture* separating. Either a stress line is produced in a material, or a stress line was built into the material at the time it was formed. The material is separated along this line by applying force. Glass can be separated to size by induced-fracture. A diamond cutter is first used to make a stress line in the glass. Once this has been done, pressure along this line (either by tapping or by pressing the line against a table edge) will cause the glass to separate.

Laboratory Activity (30)

Today the students will perform the practices of shearing, chip removing and chemical separating to make an I. D. tag.

1. The product of today's activity will be an I. D. tag with etched design.
2. Students will work individually, but groups of five will share the equipment and supplies.
3. Caution students to use a cotton swab to apply the etching cream to the I. D. tag. Although this cream will not burn normal skin, it will irritate an open cut.
4. While the tag is being etched, have the students return equipment and supplies and clean the work area. Adequate etching requires about 10 minutes; at this time have students answer and review Laboratory Manual questions.
5. Once the tag has been sufficiently etched, students are to wash off the etching cream under cold water, and dry off their part with a paper towel.
6. They will then remove the contact vinyl mask.

Safety Precautions

1. Keep fingers away from in front of knife blade when cutting mask.
2. Keep etching cream off skin, clothes, and out of eyes.
3. Wear safety glasses when using tin snips, drilling, and when etching.

Homework

Reading 54, *Shearing*

Note

1. Look ahead to Assignment 109.
2. Cut and adhere stencil film masters for patch used in Assignment 109.

Answers for Laboratory Manual

1. Shearing
2. Other processes
3. Chip removing
4. Shearing
5. Chip removing

ASSIGNMENT 109, ACTIVITY 60A
READING 54

Shearing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using information on shearing processes:
   a. Explain the difference between shearing and chip removing.
   b. Identify the steps standard stock textiles must go through to become a shirt and identify the steps in which shearing is done.

Discussion

2. Given a filmstrip presentation on shearing:
   a. State the two basic purposes for shearing.
   b. State three factors necessary for shearing.
   c. List five shearing operations.
   d. State the main advantage of shearing.

Laboratory Activity

3. Using a die cutter and the necessary equipment and supplies, shear vinyl to a predetermined size.

Time Schedule

5 Overview
15 Filmstrip Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation

Equipment

1 ea. filmstrip projector/screen

Supplies

1 Filmstrip 109, *Shearing*

Equipment and Supplies for Laboratory Activity

Equipment (Class)

3 die cutter jigs No. 109
3 rubber mallets, 16 oz.

Supplies (Group of 5)

5 pcs. contact vinyl 7″ x 9″, any color, solid

Overview (5)

1. In the last assignment, you made an I. D. tag in which you were involved in the major materials separating practices. Today you will be studying specifically about shearing, one of the separating practices.
2. In today's reading, you learned about shearing practices.
3. Today you will see a filmstrip that will show many illustrations of how shearing is done in industry.
4. In today's activity, you will use a die cutter to shear a vinyl sticker. We will add printing to the sticker in the next few activities.

Filmstrip Presentation (15)

1. As you watch today's filmstrip, keep in mind the three factors needed for shearing: a *force*, a *cutting edge*, and a *solid material.* The force is applied along a narrow line, and must be strong enough to separate material. The material sheared must be softer or weaker than the shear tool.
2. Keep in mind also that shearing may be done at any stage of production, and a wide variety of materials can be separated by shearing.
3. Show the filmstrip. You may read the suggested commentary, or paraphrase it.

Script for Filmstrip No. 109 — 14 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Shearing*
   Shearing is basically an operation that

cuts off something for the purpose of dividing or imparting shape.

5. By means of a mechanical advantage, usually a machine, a large force can be concentrated at a blade or sharp edge. This concentrated force will shear a material along a predetermined line or *axis*.
6. Shearing is done to separate and/or shape many different materials. The advantage of shearing over the other ways of separating materials is that in a shearing operation *no material is lost along the parting line.*
7. Some shearing tools are as simple as paring knives and sheet metal shears. Others are complex machines.
8. Shearing may be accomplished with a hand-operated shearing machine.
9. Power shearing is often done with a portable nibbler, a device used to shear stock to size. Here, galvanized metal is being cut to size with the use of a portable nibbler.
10. This hydraulic shear is cutting 20′ widths of steel plate. Notice the automatic controls. They are used to lift the steel plates and position them on the bed of the shearing press.
11. Large hydraulic presses are often used to form and shear material to size, in one operation. Here, automobile hoods are being formed to shape. As the hoods travel down this line, a force of 1000 tons forms and cuts the steel into the shape of an automobile.
12. This display stand and the packages which contain torch kits had to be sheared in the manufacturing process.
13. This frame shows a completely automated punching machine. All the punching operations performed by this machine are controlled by programed instructions given by an operator.
14. Credits

Discussion (5)

1. What are two basic purposes of shearing? (Dividing and imparting shape.)
2. What are three factors necessary for shearing? (A force, a cutting edge, and material.)
3. Name five shearing operations. (Answers will vary. Examples are: (a) Cutting an apple with a knife. (b) Using a cutting die to cut felt for a pennant. (c) Punching holes in metal with a punch press. (d) Cutting sheet metal with tin snips. (e) Producing automobile body parts on hydraulic presses.)
4. What is the main advantage of shearing over the other techniques of material separating? (No material is lost along the parting line.)

Laboratory Activity (20)

In today's activity, the students will use a die cutter to shear a shape from vinyl.

1. Briefly demonstrate to students how to use die cutter. Emphasize conservation of vinyl material. Point out that die cutting in industry is *not* done by hammering, but by a continuous pressure.
2. Show how to fold the 7″ x 9″ piece of vinyl into a 7″ x 4½″ size. Place the folded piece of vinyl in the die cutter. All cutting edges must be covered with vinyl.
3. Show how to place the cover over the vinyl and hammer firmly one time with the mallet along the cutting edges outlined on the top of the cutter. If the component is not entirely sheared, replace the cover and hammer again as needed.
4. Have groups rotate at your direction. This is necessary due to lack of equipment.
5. Remind students to label their components.
6. If all components are not sheared in this period, additional time can be used in the next activity for this purpose.

Homework

None

Note

1. Remove pattern sheet from Teacher's Guide, Fig. 110-1. Make a spirit master and duplicate, one per student, for use in ACTIVITY 60B.
2. Prepare three silk screens for use in ACTIVITY 61. The teacher can create the design for the stencils (such as "booster" or "racing team") and adhere the stencils to the silk screens.

ASSIGNMENT 110, ACTIVITY 60B

Shearing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation on shearing:
   a. Name five examples of materials that can be sheared to shape.
   b. State the advantage of die cutting.
   c. Name five examples of die-cut components.

Laboratory Activity

2. Using the necessary equipment and supplies, shear a paper stencil.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5 X-acto® knives *or* single-edge razor blades

Supplies (Group of 5)

5 pcs. waxed paper 6″ x 8″
5 pcs. printed-pattern sheet
1 roll masking tape

Overview (5)

1. Yesterday you learned that shearing can be done by many different methods.
2. Yesterday you used a die cutter to shear a vinyl material into a sticker.
3. Today, you will be asked to give examples of components that have been die cut.
4. In today's activity, you will perform another kind of shearing using a simple tool.

Presentation (5)

1. Shearing is a separating practice that can be done with a simple tool or very complex and expensive machinery.
2. Many different materials can be separated by shearing. Almost any shape can be cut by shearing.
3. The advantage of shearing over the other ways of separating materials is that in a shearing operation no material is lost along the parting line.

Discussion (5)

1. Name five examples of materials that can be sheared to shape. (Cloth, leather, plastic, cardboard, thin metal, etc.)
2. If you had 1000 pieces of sheet metal that had to be cut to size, why would it be advantageous to use a shearing process? (More components could be cut because there would be no chips or waste.)
3. Name five examples of die-cut components. (Cardboard box, clothing parts, gaskets, balsa wood model airplanes, postage stamps, etc.)
4. Why are some materials sheared on a machine? (Some materials may require great strength to shear. The mechanical advantage of a machine provides this strength.)

Laboratory Activity (30)

Today the students design and shear a stencil to be used in coating the component cut in the previous activity.

1. Remove or trace the pattern sheet, Fig. 110-1, from the Teacher's Guide and make a spirit master. Duplicate pattern sheet, one per student.
2. Each student will design and shear one stencil for use in the next activity.

Safety Precautions

1. Caution students to use X-acto® knives or razor blades with care.

Homework

None

Note

Look ahead to Assignment 112 and 113 and precut wood stock (¾″ x 4″ x 12″) and plastic vinyl for ACTIVITY 62A and B.

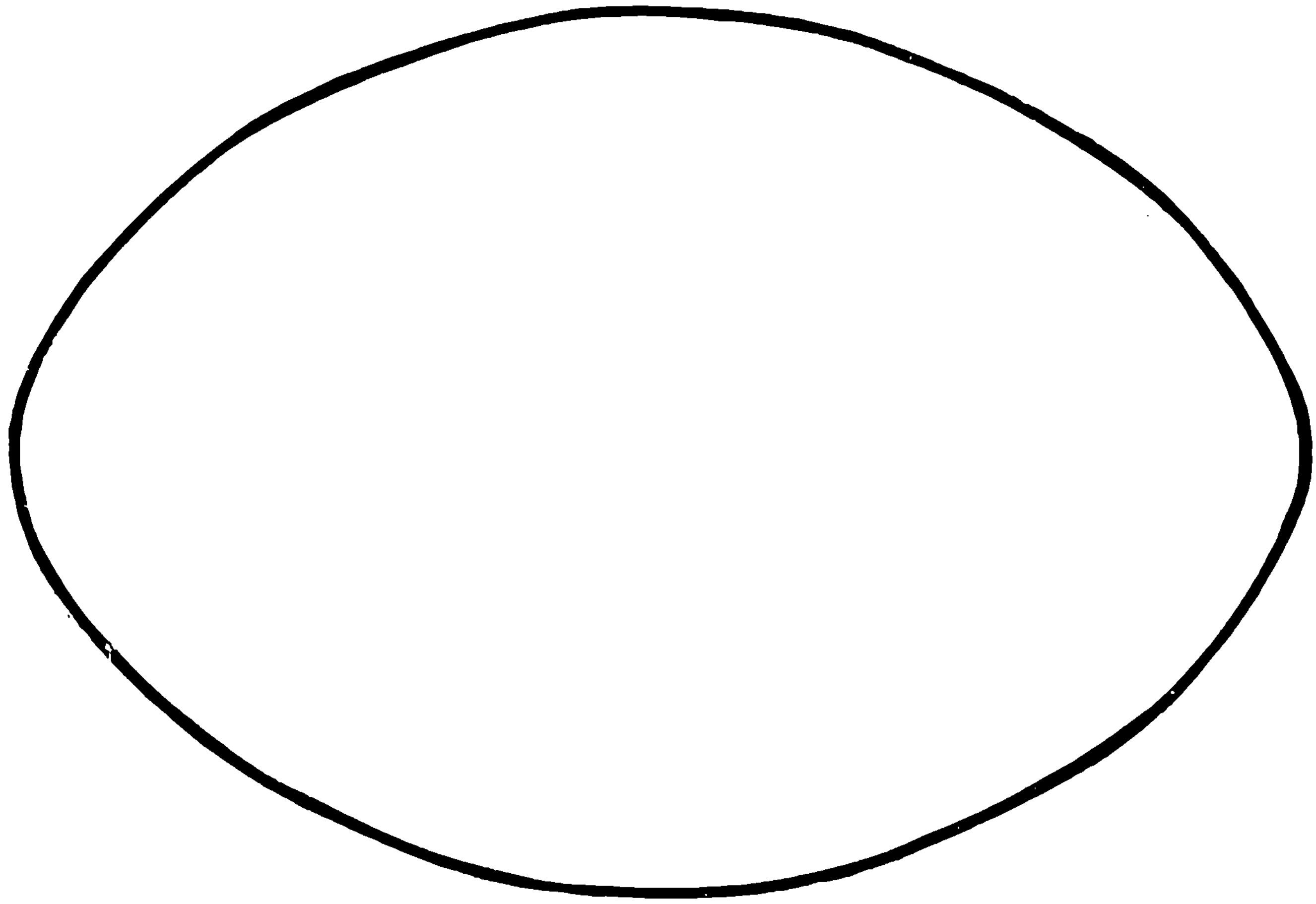


Fig. 110-1. Pattern Sheet
Trace the above pattern for duplication.

ASSIGNMENT 111, ACTIVITY 61

Combining Components

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given questions on coating:
   a. Describe coating.
   b. Name five reasons for coating material.
   c. Tell how coating is related to bonding.
   d. Name ten examples of coating materials and processes.

Laboratory Activity

2. Using the necessary equipment and supplies:
   a. Coat a component by screen-stencil printing.
   b. Coat a component by spray-stencil printing.

Time Schedule

5 Overview
5 Presentation
5 Discussion
5 Demonstration
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

3 prepared screen stencils
3 squeegees

Supplies (Group of 5)

5 components, from ACTIVITY 60A-1
5 stencils, from ACTIVITY 60B
1 can spray paint, quick dry
1 btl. rubber cement, with applicator cap

Supplies (Class)

3 qts. screen-stencil paint, any color

Overview (5)

1. Today I will tell you about combining components and stress coating as a manufacturing process. I will talk about the three types of coatings, their uses, and examples of each type.
2. You will be asked to give examples of coating materials and methods.
3. In today's activity you will coat the sticker by screen-stencil printing and by spray-stenciling.

Presentation (5)

1. There are three types of *coatings*: organic, inorganic-nonmetallic, and metallic.
2. *Organic* substances are obtained from living things or from material that was once living. Varnish and lacquer are examples of organic-base coating.
3. *Inorganic* substances have never been alive. One example of coating material derived from inorganic substances is porcelain enamel on bathtubs. It is made from clay, quartz, and other minerals.
4. *Metallic* coatings are used in coating and plating operations. Zinc, nickel, chromium, and copper are metals used as coating.

Discussion (5)

1. What does coating mean? (Covering one material with another.)
2. Give five reasons for coating materials. (To decorate; to protect; to seal; to control the absorption or reflection of light, heat, and sound; to help in keeping a surface sanitary.)
3. How are coating practices related to bonding practices? (Coating materials with adhesives is the first step in some bonding procedures.)
4. Name five coating materials. (Enamel, chrome, rubber, vinyl, varnish.)
5. Name five ways of coating. (Brushing, spraying, printing, dipping, plating.)

Demonstration (5)

1. Briefly demonstrate screen-stencil procedure. Place material into registered position, lower screen and squeegee paint across.
2. Demonstrate procedure for spray-stenciling. Coat back of stencil with a *small* amount of rubber cement so it will adhere to sticker and spray.

Laboratory Activity (25)

Today students will screen-stencil a design on their sticker and (using the paper stencil cut in the previous activity) spray a design on the sticker.

1. All students will use one of the screen stencils which have been prepared by the teacher. Colors may be school colors.
2. Teacher must assign order in which groups rotate using the screens. Students can work on either problem.
3. Allow time for cleanup. Screen stencil must be cleaned after each class.
4. Have students complete Fig. 61-8, Process Checklist (Sticker).

Homework

Reading 55, *Chip Removing*

Note

Look ahead to Assignment 113 and cut stock to length for number of students in each class.

Look ahead to Assignment 116 and make fine glass cutting jigs No. 116-1. See Fig. 116-10.

Answers for Laboratory Manual

Figure 61-8, Process Checklist (Sticker):

5. die cutting (sticker), knife cutting (stencil)
8. adhesion
10. screen, spray

ASSIGNMENT 112, 113
ACTIVITY 62A, B, READING 55

Chip Removing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about the processes of chip removing:
   a. Name some of the single-edge and multiple-edge tools found around the home.
   b. Give reasons why it is more economical to use chip removing processes for making a small number of parts, rather than a large number of parts.

Discussion

2. Given a demonstration on laying out a half-pattern:
   a. State the procedure used to lay out a pattern for a house-marker panel.
   b. State the procedure used to lay out and shear a contact stencil for the house marker.
3. Given a filmstrip presentation, name several chip removing processes.
4. Given the necessary equipment and supplies:
   a. Perform sawing, sanding, drilling, and filing operations to produce a house-marker component.
   b. Perform shearing operations to produce a contact vinyl house-number stencil.

Laboratory Activity

5. Use the proper equipment and supplies to produce the house-marker components by performing the operations of (1) sawing, (2) sanding, (3) drilling, (4) filing, and (5) shearing.

Time Schedule

Assignment 112
5 Overview
15 Filmstrip Presentation
10 Demonstration
5 Discussion
10 Laboratory Activity

Assignment 113
5 Demonstration
40 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation

Equipment

1 filmstrip projector w/screen

Supplies

1 Filmstrip 112, *Chip Removing*

Equipment and Supplies for Laboratory Activity

Problem 1

Equipment (Group of 5)

1 power sander, if available
1 crosscut saw
4 coping saws
1 bandsaw *or* jigsaw, if available
1 ea. 1/16", 1/8", 1/4" twist drills
1 hand drill *or* drill press
1 scratch awl
3 pr. scissors
1 12" rule
1 wood file
1 countersink
1 brace

Supplies (Group of 5)

5 pcs. 3/4" x 3 1/2" x 12" wood, clear white pine S4S, *or* equivalent. Dressed width of 4" stock is satisfactory for 3 1/2" width
1 sht. medium-grit abrasive paper

Problem 2

Equipment (Group of 5)

5 X-acto® knives
5 pcs. 1/8" x 12" x 12" hardboard
1 set 2 1/2" Gothic-numeral stencils
5 12" rulers
5 felt tip marking pens, fine point

Supplies (Group of 5)

5 pcs. 4" x 12" dark-colored contact vinyl

Overview (5)

1. When you were die cutting the badge you were shearing; you were performing a material-separating practice. Today you will continue to separate material by the chip removing process.
2. In your reading you were introduced to separating by chip removing and to the tools and processes industry uses to perform chip removing.
3. Today I will show you how to use a "half-pattern" to lay out a house-marker panel. You will also see how to lay out the numbers that you will shear from contact vinyl.
4. During the next two days you will form components by chip removing and shearing processes.
5. You will see a filmstrip showing various chip removing processes.
6. You will be asked to identify the two classes of chip removing processes.
7. You will be asked to give the major advantages and disadvantages of chip removing when compared with other ways of separating materials.
8. In the laboratory activity you will have the opportunity to perform sawing, filing, sanding, and drilling operations.

Filmstrip Presentation (15)

The filmstrip to be presented today concerns chip removing.

Script for Filmstrip No. 112 — 30 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Chip Removing*
   Chip removing is one basic way of separating materials. It involves removing small amounts of material in the form of chips, shavings, sawdust, or similar small bits. The tool may have one cutting edge or several. To shape the material, the chip removing tool must be harder and tougher than the material.
5. When separating materials, a *parting line* is usually made by the cutting tool. When the material is separated to size or shape by chip removing, the piece or pieces that remain are smaller than the original piece of stock.
6. The lathe is the most important machine that uses a single-edge cutting tool. This machine is used to reduce round objects to shape. The cutting tool of a lathe operates like a knife peeling an apple.
7. This frame shows the cutting tool of a lathe separating material that is rotating against it.
8. The shaper is another machine that uses a single-edge cutting tool to remove material. This diagram shows how the shaper operates. The *work* is stationary. The *cutting tool* moves against it to remove material.
9. The slotter, which operates somewhat like a shaper, is shown here removing stock with a vertical tool movement.
10. The planer is another machine that uses a single-edge cutting tool to remove small bits or chips of material from a workpiece. The difference between the planer and the shaper or slotter is that when a planer is in use, the *workpiece* moves and the *cutting tool* is stationary.
11. Here rough castings of a lathe are being machined to shape by a large planer. Notice that two castings are being machined to size at one time on this machine.
12. Here four airplane propeller blades are being cut to size by a planer.
13. Multiple-edge cutting tools are also used to remove chips of material in shaping a workpiece. *Sawing* is a common way of chip removing using a multiple-edge cutting tool.
14. Sawing can be done by hand or with a portable power tool.
15. Saws are also used to separate metal. Notice that unwanted material is being removed in the form of chips.
16. Drilling is another way of chip removing that uses a multiple-edge cutting tool.
17. Drilling can be done with a hand drill or (as shown in this frame) with a portable power drill.
18. Drilling can also be performed on a stationary drill press.

19. *Milling* is another way of separating materials by chip removing with a multiple-edge cutting tool. The milling machine uses a cutting tool that rotates against a workpiece. The workpiece also moves. Thus, a smooth, flat cut is produced along the surface of the workpiece.
20. The jointer, a woodworking machine, operates on the principle of the milling machine in removing material from wood to give it shape.
21. Here a profile milling machine, following a template, is milling three pieces of stock at the same time.
22. *Grinding* is another way of chip removing that uses a multiple-edge cutting tool. In grinding, the cutting edges are bits of abrasive material bonded together in the form of a wheel or stone.
23. A portable power grinder is being used to shape this rough casting.
24. Grinding can also reduce flat stock to a very close tolerance. This surface grinder is finishing boiler plate to a smooth, true finish.
25. Close tolerances of an automobile crankshaft are obtained by a grinding operation.
26. One other way of chip removing that uses a multiple-edge cutting tool is *sanding*. Sanding employs an abrasive material. The abrasive may be natural or manmade. It is bonded to a flexible cloth or paper backing. The small particles of abrasive material remove small chips from the workpiece when moving pressure is applied.
27. Sanding can be done by hand or with a portable pad sander, commonly used in woodworking.
28. Sanding can also be done with a belt sander. The abrasive material is bonded to an endless belt made of a flexible material.
29. The abrasive material can also be cut in a circular pad and used on a circular sander. This frame shows an automobile assembly man sanding blemishes off the surface of an automobile hood.
30. Credits

Demonstration for Problem 1 (10)

In ACTIVITIES 62A and B, students will use a half-pattern to transfer a design onto a piece of wood and produce a house-marker panel by chip removing operations, and trace cardboard onto contact vinyl for shearing and bonding numerals to the house marker.

Have students open their Laboratory Manuals to today's activity.

1. Using a student's Laboratory Manual, demonstrate how to remove the pattern page from the manual. Caution students to be careful so they will not tear their Laboratory Manual.
2. Demonstrate how to cut out a half-pattern.
3. Show the students how to lay out the half-pattern on the wood so that the center line of the pattern is in the center of the workpiece.
4. Trace around the half-pattern with a pencil. Caution the students *not to move the pattern*, or the lines of their design will not line up properly.
5. Demonstrate how to reverse, or "flip" the pattern over, and complete tracing around the reverse side of the pattern onto the stock.

Demonstration for Problem 2 (5)

6. Demonstrate how to lay out numerals on contact vinyl using cardboard numeral patterns.

Discussion (5)

1. What are the two basic classes of chip removing tools? (Single-edge tools such as a plane and multiple-edge tools such as a saw.)
2. What are the major disadvantages of chip removing as a separating process? (It wastes material. Highly skilled workers may be required. Operating costs are high.)
3. What are the major advantages of chip removing processes? (Few dies or special fixtures are needed. Many of the tools are inexpensive. Some chip removing operations are very accurate.)
4. Can you name several chip removing processes?
   a. Sawing
   b. Lathe work
   c. Shaping
   d. Planing
   e. Slotting
   f. Drilling
   g. Grinding
   h. Sanding
   i. Milling

5. Why is it important that you cut your paper pattern carefully? (It will determine the final shape of your component.)
6. What do you do after you have traced around the half-pattern onto the wood stock? (Reverse the pattern and trace onto the other half of the workpiece, being careful to align both halves.)
7. Why must you be careful not to move the pattern when tracing it onto the stock? (The lines of the two halves will not line up if the pattern slips.)

Laboratory Activity (10) (40)

Problem 1 (10) ACTIVITY 62A
Problem 2 (40) ACTIVITY 62B

1. Students will produce two components: a house-marker panel (Problem 1) and numbers or letters for house-marker panel (Problem 2).
2. Each student will produce his own components, but groups of five students are to share tools.
3. The boards for house-marker panels can be precut to 12″ lengths to save time, or the students can saw their components from longer standard-stock lengths.
4. Sanding after sawing should be a brief finishing operation, done with power equipment if possible. It is not included for skill development. Caution the students to sand the visible end-grain adequately. Light sanding of the stock surfaces will also be necessary.
5. Students will need to select a method of mounting the house marker. The three methods suggested are: screw eyes, direct mounting to the wall, or a steel rod for a center post. They should refer to Figs. 62A-5 and 62A-6 to determine hole locations for the mounting method they select.
6. When a student believes that his component 62A, house-marker panel, is completed, he is to have you check it. If it is satisfactory, have the student label it, store it where you designate, and proceed to the other problem.
7. Using the felt-tip pen and cardboard numerals, have each student trace his numbers onto the sheet of vinyl. After tracing, numerals can be sheared with the X-acto® knife. This is component 62B, and it is manufactured by shearing.
8. Have students complete and label components 62A and 62B. After satisfactory completion, store until students' next activity period, ACTIVITY 63, Combining Components.

Safety Precautions

1. Wear goggles when using power equipment.
2. Never saw or drill toward any part of the body.
3. Caution students shearing house numbers to cut only on a hardboard surface and to use extreme care.

Homework

After ACTIVITY 62A, none. After ACTIVITY 62B, assign Reading 58, *Combining Components.*

Answers for Laboratory Manual

1. Sanding, sawing, drilling, filing (in any order).
2. Sanding: mutiple-edge tool.
   Filing: multiple-edge tool.
   Sawing: multiple-edge tool.
   Drilling: multiple-edge tool.
3. The lines of the pattern will not align properly.
4. Wasteful.
5. Mechanical.
6. Tool.
7. Semiskilled.
8. Parting line.
9. Tools or dies.
10. a. Single-edge cutting.
    b. Multiple-edge cutting.
11. Sawing, drilling, filing, sanding (in any order).
12. Sawing or drilling (answers will vary).
13. Sanding.

ASSIGNMENT 114, ACTIVITY 63
READING 58

Combining Components

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on combining components:
   a. List the ingredients that were mixed together to produce foods in a liquid form, solid form, and powdered form.
   b. Look at a product in the home (a bed, for example) and identify which parts were coated, bonded, and mechanically fastened.

Discussion

2. Given a presentation and examples, describe in their own words the changes that occur during some mixing, coating, and bonding of materials.

Laboratory Activity

3. Using the manufactured components 68A and 68B that require adhesive bonding and coating, coat and bond the components to produce the finished house-marker product.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 set Transparencies:
- 114-1. *Combining Components by Mixing*
- 114-2. *Combining Components by Coating*
- 114-3. *Combining Components by Adhesive Bonding*
- 114-4. *Combining Components by Fusion Bonding*
- 114-5. *Combining Components by Mechanical Fastening*

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1 cardboard box, 10″ x 15″ x 20″ for spray booth

Supplies (Group of 5)

5 pcs. house-marker panels, component 62A
5 contact-vinyl number stencils, component 62B
2 cans aerosol quick-drying spray enamel, any color combinations, at spray booth

Overview (5)

1. Yesterday, using a chip removing process and a shearing process, you produced two components, the house-marker panel and the contact-vinyl stencil.
2. Your reading assignment explained that components are *combined* in four basic ways: by *mixing, bonding, coating,* or *mechanical fastening.*
3. Today I will explain more about mixing, coating, bonding, and mechanical fastening.
4. You will be asked to identify components of various assemblies and decide how they were combined.
5. During today's laboratory activity you will perform coating and bonding operations.

Presentation (10)

Today's lesson concerns the four basic ways of combining components.

1. Show Transparency 114-1, *Combining Components by Mixing.* Mixing is the movement of particles of two or more components until they are *evenly* distributed.
   a. Particles of two components are represented here by dots and X's.
   b. These particles might be molecules that are too small to be seen, or they might be large, visible particles.
   c. The particles may be a solid, a liquid, or a gas.
   d. Steps 1 and 2 show that each com-

ponent is a measured quantity. Materials are measured by *weight* or *volume.*

e. Steps 3, 4, and 5 show how stirring distributes the particles evenly.

2. Show Transparency 114-2, *Combining Components by Coating.* Coating means *applying* one material over another.
   a. Often a thin layer of one component is spread over the surface of a second component. It is a *physical* coating if the two components do not mix.
   b. The evenness and thickness of the coating layer are controlled by the process of application.
   c. Some components are coated *chemically.* The coating component mixes or combines chemically with the coated component. The surface molecules of aluminum readily combine chemically with oxygen and form a coating of aluminum oxide.
3. Show Transparency 114-3, *Combining Components by Adhesive Bonding.* There are two ways to *bond* components. One group of processes is called *adhesive bonding* or *adhesion.*
   a. For adhesive bonding, an adhesive material such as paste, glue, or solder is applied. It creates a surface bond between the two components.
   b. The molecules of the adhesive attach to molecules on the surface of each component.
   c. Hardening or curing usually causes the bonds between molecules to grow stronger, until the bonded joint may be stronger than either component. NOTE: The adhesive material on contact vinyl does not harden or cure.
4. Show Transparency 114-4, *Combining Components by Fusion Bonding.* Fusion bonding means that *molecules from each component are mixed together* at the joint or interface.
   a. The components are placed close together.
   b. Heat or pressure is applied (sometimes both).
   c. The surfaces become liquid or fluid.
   d. Molecules of one component mix with molecules of the other component.
   e. When heat and/or pressure is removed, the mixed molecules become solid and form one material.
5. Show Transparency 114-5, *Combining Components by Mechanical Fastening.* Mechanical fastening uses *friction or mechanical force to hold components together.*
   a. Bolts, screws, and studs are classified as threaded fasteners.
   b. Thread, lace, rope, wire, rivets, nails, and keys are examples of non-threaded mechanical fasteners.
   c. Most mechanical fasteners permit the assembly to be taken apart easily.
6. The manufacturer combines components to produce the product. The manufacturer combines components by mixing, coating, bonding, or mechanical fastening.
   a. *Mixing* involves *measuring* each of the components to be mixed, agitating or moving the particles so they intermingle, and deciding when mixing is complete.
   b. *Coating* is somewhat like adhesive bonding, since the coating material *adheres* to the component being coated.
   c. *Bonding* can be accomplished by adhesion or fusion.
   d. *Mechanical fastening* often uses the mechanical force of friction. Fasteners may be classified as *threaded* or *nonthreaded* mechanical fasteners.

Discussion (5)

1. When sugar and water are mixed together, what happens to the sugar? (The sugar dissolves. It breaks into individual molecules which mix between the molecules of water.)
2. If iron castings are stored in an area exposed to the weather, what happens to the surface of the iron? (The iron rusts, unless a coating has been applied to prevent oxidation of the iron surface.)
3. Why is it difficult to glue pieces of wood together if the wood has wax or oil on it? (Glue does not stick (adhere) to oil or wax.)
4. What would happen if unwrapped bars of chocolate were stacked up and stored in a warm room? Why? (Some bars would bond together by fusion, because heat would soften the chocolate, and the weight of the bars on top would press together the ones underneath.)

5. Why does it take less mechanical force to loosen a nut if the bolt threads have oil on them? (Oil reduces the amount of friction between the threads of the nut and bolt. Friction keeps a nut tight on the bolt.)
6. Have students complete Fig. 63-4, Processing Checklist (House Marker).

Laboratory Activity (25)

1. Students will produce the finished house-marker panel.
2. Each student will coat and bond his own components. Groups of five students are to share tools.
3. When a student believes that his house marker is completed, he is to have it checked by the teacher.

Homework

Reading 56, *Separating by Other Processes*

Answers for Laboratory Manual

Figure 63-4, Processing Checklist (House Marker)

4. Filing, sawing, sanding
5. Stenciling
7. Mixing by stirring
8. Gluing
9. Screwing
10. Spraying

Note

Look ahead to Assignment 116. Collect three or four round soda pop bottles with a smooth cylindrical shape and practice the separating process which is illustrated.

ASSIGNMENT 115 ACTIVITY 64A
READING 56

Separating by Other Processes

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on separating by other processes:
   a. Explain how advances in nontraditional processes of separating have helped in miniaturization.
   b. Explain the differences between thermal erosion, chemical separating, electrochemical separating, and induced-fracture separating.

Laboratory Activity

2. Using a filmstrip presentation, demonstration, and examples of processes, classify each example as thermal erosion, chemical separating, electrochemical separating, or induced-fracture separating.

Time Schedule

5 Overview
15 Filmstrip Presentation
20 Demonstration
5 Laboratory Activity

Equipment and Supplies for Filmstrip Presentation and Demonstration

Equipment

1 electrical discharge machine and accessories
1 filmstrip projector w/screen

Supplies

1 qt. dielectric electrolyte solution (Texaco 499 EDM). 1 gal. will be required if each class does not filter the liquid before reuse.
1 workpiece .020″ to .030″ x 1″ x 1¼″ alum. (The thicker the workpiece, the longer it takes to demonstrate the cut.)

1 Filmstrip 115, *Separating by Other Processes*

1 sht. filter paper *or* paper towel

Overview (5)

1. Recall that earlier in the year we classified separating into three groups of processes: (1) shearing, (2) chip removing, and (3) other nontraditional processes. So far, we have separated materials by shearing when we cut the aluminum I. D. tags, die-cut the sticker, and cut the paper stencil for the sticker.
2. Today we will look at four nontraditional separating processes.
3. Your textbook lists four major classifications in the general group called "Separating by Other Processes."
   a. Induced fracture, such as cutting part way through sheet glass, and then breaking it along the scored line.
   b. Chemical separating, such as etching the surface of glass.
   c. Thermal erosion, such as occurs in using a cutting torch, a laser, or an electrical discharge machine.
   d. Electrochemical separating, as demonstrated in electrochemical machining.
4. You will see a filmstrip illustrating these processes of separating. You will also see a demonstration of electrical discharge machining.
5. You will use knowledge you gain from the lesson to answer questions in the Laboratory Manual about some of these nontraditional or "new" processes of separating.

Filmstrip Presentation (15)

Today's presentation concerns "Separating by Other Processes."

Proceed with the filmstrip. You may read or paraphrase the script.

Script for Filmstrip No. 115 — 27 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Separating by Other Processes.*
   Advances in technology have brought demands for new and different ways of separating materials. Many new processes have been developed to meet the demands. These, along with some of the more unusual separating processes, form a loose group that we might call the "nontraditional" processes. They can be broken down into four categories:
   a. Thermal erosion
   b. Chemical separating
   c. Electrochemical separating
   d. Induced-fracture separating
5. Flame cutting is one of the processes in the thermal-erosion category. Flame cutting separates materials by melting and blowing away a part of the material along a separating line.
6. A new thermal-erosion process is plasma-arc machining. Burning gases are used to melt the metal. Electrical charges moving through the burning gases force the melted metal away from the area. Plasma-arc machining is much faster than flame cutting.
7. Here is an example of plasma-arc machining. Notice the electrical line connected to the tip of the cutter.
8. Another way of separating by thermal erosion is electrical discharge machining (EDM). This process will be demonstrated to you later today. Notice that the tool is connected to one terminal of a power source, and the workpiece to the other terminal. The current causes particles of material to be eaten away, or eroded, from the workpiece and dispersed in a nonconducting liquid (dielectric). The work is separated to the shape of the tool conducting the sparks.
9. This is an example of a stamping die that has been made by electrical discharge machining. The die is still mounted in the machine. However, the nonconducting liquid has been removed.
10. A second important way of "separating by other processes" is chemical separating. An important process in this category is etching. The printed circuit board shown here is an example of a product made by chemical etching.
11. *Step 1.* A material called *resist* is used to cover areas which will remain as part of the circuit. The silk-screen frame

shown here is sometimes used for applying resist to a circuit board.

12. *Step 2.* The shape of the circuit is cut into a stencil.
13. *Step 3.* The stencil is bonded to the silk-screen frame and a newspaper is taped over the stencil to cover the openings around the stencil.
14. *Step 4.* A plastic and copper circuit board is placed under the silk screen and liquid resist is squeezed through the stencil onto the copper.
15. *Step 5.* The circuit plate, blocked out with resist, is etched. All areas of the board *not* coated with resist will be eaten away by the acid.
16. *Step 6.* The final steps in the production of the circuit board are to remove it from the etching solution and to remove the blockout material that covers some parts of the circuit.
17. Here is an example of a power supply that has been designed and wired on the printed circuit board we saw earlier. The strips of copper on the bottom of the board connect the parts we see on the top.
18. A third way of "separating by other processes" is *electrochemical machining* (ECM). An electrolyte (an electrically conducting solution such as salt water) is pumped through the gap between the tool and the workpiece. Electric current passing through the solution between the tool and the workpiece removes material (by electrolysis) from the workpiece, leaving a shape exactly like the shape of the tool.
19. Here is a picture of an electrochemical machine. The large section at the right is a filter network which removes metal particles from the chemical solution.
20. This is an example of a part that has been made by electrochemical machining. Notice the complex shape that was produced from the original rectangular piece of stock. Both parts will be used as components in later assembly operations.
21. The fourth and last category of "other processes" is induced-fracture separating. By producing a stress line in a material, or using stress lines built into the material at the time it was formed, a material can be separated along these lines by applying force. Glass can be separated by the induced-fracture method. A glass cutter is first used to score a mark in the material. After the glass has been scored, pressure along the line will cause the glass to fracture.
22. Here is a professional glass cutter scoring glass. This sheet of glass will later be broken along the score line by induced fracture. The process is called "glass cutting" even though the cutting or scoring is only the first part of the process. You will use this process in the next activity.
23. This connecting rod is separated along the marked line by induced fracture. When the part is formed, it is cast with a score line that will later guide the line of fracture. It must be separated to be installed onto a crankshaft of an engine. It will break into two parts when force is applied at the point illustrated.
24. This coal miner is drilling into an underground vein of coal. A charge will be placed into the hole and exploded. Small pieces of coal can be carried out of the mine. The coal will separate into smaller pieces because of the built-in stress lines in the material. These lines were formed in the coal thousands of years ago. The explosion causes separating by induced fracture.
25. All wood has a grain or stress line. When an ax or other tool is forced into the wood in the right direction, the wood will separate along the grain or stress lines.
26. The wooden shingles for the roof of this house were separated to size by induced-fracture separating.
27. Credits.

Demonstration (20)

Prepare the EDM demonstration by setting up and testing the equipment.

1. Select an insulated (wood) work surface near an electrical outlet. The EDM equipment operates with electricity, and it must be set up so no one is given an electrical shock.
2. Study the assembly and operating instructions as provided by the manufac-

turer of the EDM equipment. See Fig. 115-1.

3. Select and position the workpiece into place for cutting. (.020″ to .030″ recommended thickness.)
4. Select and adjust the cutting tool into position for cutting. The cutting tool should not contact the workpiece. The pilot light on the side of the machine will be "on" when the tool is not cutting the workpiece. To adjust the tool, turn the knob counterclockwise for the downward adjustment. See Fig. 115-2.
5. Pour the correct amount of dielectric solution in the glass beaker.
6. Explain that direct current is needed to perform the operation. The rectifier changes alternating current from a power line (the wall outlet) into direct current.

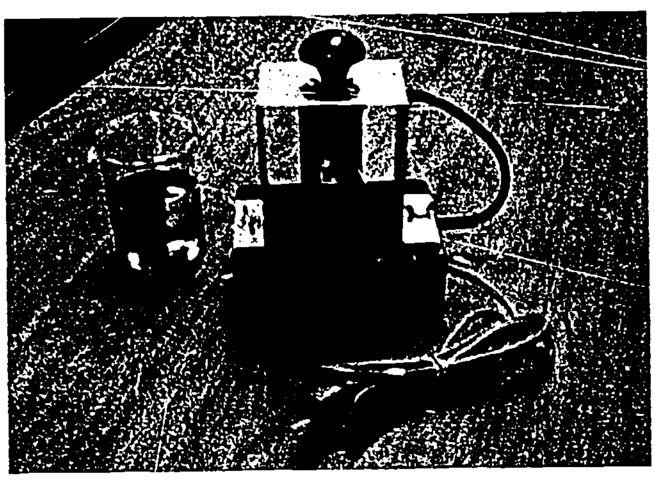


Fig. 115-1. Recommended Equipment for Demonstrating the Electrical-Discharge Machining Process

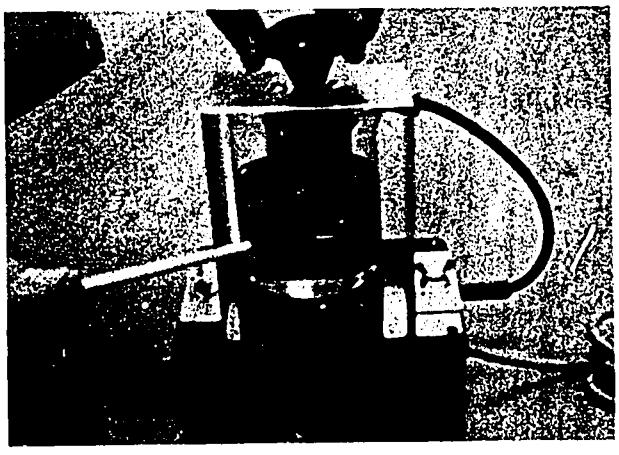


Fig. 115-2. Select and Adjust the Cutting Tool

Fig. 115-3. Arc Light from Electrical Discharges

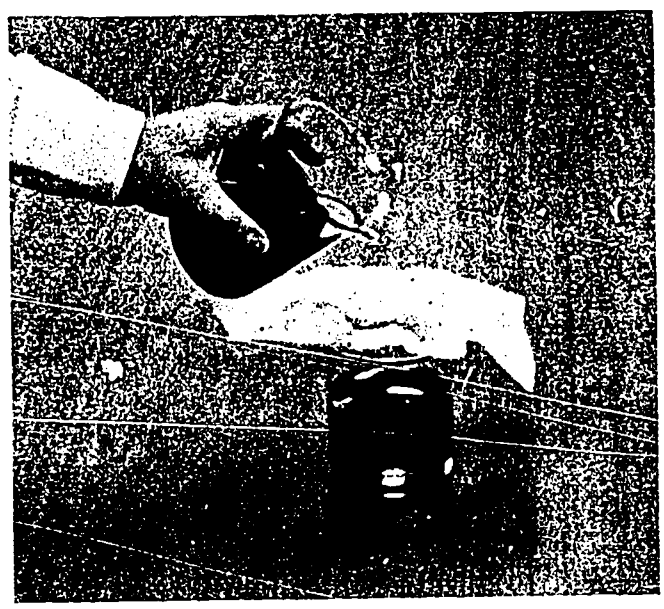


Fig. 115-4. Pouring Off the EDM Solution

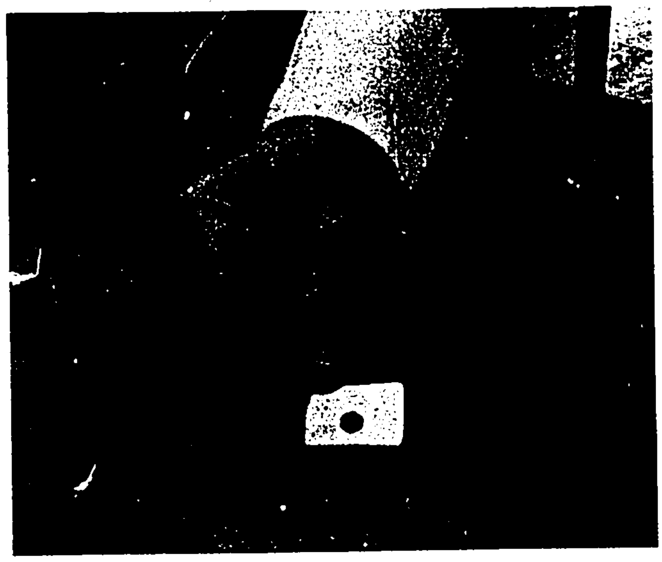


Fig. 115-5. Discuss the Machining Results from the Demonstration

7. Turn the power on with the cutting tool adjusted away from the workpiece.
8. Carefully adjust the cutting tool toward the workpiece until you hear an even, crackling sound of electrical arcs between the tool and the workpiece. If the sound becomes irregular, adjust the tool to maintain an even sound. When the cutting tool is properly adjusted, the pilot light will not be on. If the pilot light flashes intermittently, this indicates that the cutting tool needs adjustment to maintain a consistent cutting action.
9. Point out the arc light between the cutting tool and the workpiece. See Fig. 115-3. You may want to review the process with the students as the machining continues. The actual process should take about 5 to 10 minutes.
10. After the tool has been adjusted all the way through the workpiece and arcing no longer occurs, the process is complete.
11. CAUTION! Turn off the electrical supply to the machine.
12. Remove the dielectric solution and the workpiece from the beaker. Strain the dielectric solution through a paper filter so it may be reused, Fig. 115-4.
13. Show the hole in the workpiece and discuss EDM benefits in manufacturing. See Fig. 115-5.

Laboratory Activity (5)

Students will answer some questions about electrical discharge machining and classify 10 processes in one of the categories covered in the filmstrip presentation.

1. Have the students open their Laboratory Manuals and answer the questions.
2. Discuss the correct answers if time permits.

Safety Precautions

1. Be sure the machine is properly assembled before operating.
2. Instruct students to move their seats into a half-circle around the demonstration and to remain in their seats. It is dangerous for anyone to touch the metal parts and the electrode until the machine is unplugged.

Homework

None

Note

Sources of Information on EDM and ECM:

Johnson, Harold V., *Technical Metals*. Peoria, Ill.: Chas. A. Bennett Co., 1968.

Walker, John R., *Machining Fundamentals*. Homewood, Ill.: Goodheart-Wilcox Co., Inc., 1969.

Walker, John R., *Modern Metalworking*. Homewood, Ill.: Goodheart-Wilcox Co., Inc., 1968.

Answers for Laboratory Manual

1. Direct
2. Spark
3. Cannot
4. Dielectric
5. a. ECS
   b. TE
   c. TE
   d. TE
   e. CS
   f. IFS
   g. ECS
   h. CS
   i. IFS
   j. TE

ASSIGNMENT 116, ACTIVITY 64B

Separating by Other Processes

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a demonstration on how to separate glass by induced fracture, state how to separate glass plate and circular glass (such as a bottle) by induced fracture.
2. Given a demonstration on chemical separating, etch a design on plate glass.

Laboratory Activity

3. Using the appropriate equipment and supplies, cut and etch glass.

Time Schedule

5 Overview
10 Presentation-Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Demonstration

Equipment

1	sanding block
1	oil can
1	glass cutter
1	propane torch
1 pr.	gloves
1	glass sheet cutting jig No. 116-1
1	glass bottle separating jig No. 116-2

Supplies

1	round soda pop bottle
1 pc.	3″ x 12″ plate glass, single thickness
1 sht.	silicon carbide abrasive paper, medium grit

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1	try square
4	sanding blocks
1 pr.	gloves
3	X-acto® knives
4 prs.	scissors
1	oil can
1	glass cutter
1	grease pencil
1	24″ bench rule
1 pc.	12″ x 12″ *smooth* hardboard
5	glass cutting jigs No. 116-1

Supplies (Group of 5)

5 pcs.	3″ x 3″ contact vinyl, plain light color
3 shts.	3″ x 12″ plate glass, single thickness
1 sht.	silicon carbide abrasive paper, medium grit

Supplies (Class)

5 tubes 1½ oz. size glass-etching cream

Overview (5)

1. Yesterday you observed material separation by electrical discharge machining.
2. Today I will demonstrate how to separate glass by induced fracturing. You will also apply a contact vinyl mask to the glass and then etch the glass.
3. While you are waiting for the glass to be etched, I will demonstrate how to separate a bottle by inducing the fracture.

Presentation - Demonstration (10)

As part of today's laboratory activity, the students will cut glass, using an induced-fracture separating operation. This demonstration will show them the procedure to follow:

1. Refer to the procedure for separating glass which has been illustrated in the Laboratory Manual.
2. Place glass on jig No. 116-1 as shown in Fig. 64B-1.
3. Oil the glass cutter wheel as illustrated in Fig. 64B-2.
4. Demonstrate how the glass cutter is used by drawing it across the glass at the approximate angle illustrated in Fig. 64B-3. Remind students that the induced fracture must be made in *one stroke.* Attempting to make a second pass with

the glass cutter will cause uneven breaks.

5. The fracture line should extend completely across the *surface* of the glass.
6. Using the edge of a wooden table or bench, break the glass along the induced fracture. Gloves and safety glasses should be worn during this operation. See Fig. 64B-4.
7. Using a sanding block and silicon carbide abrasive paper, smooth the *edges* of the glass. Wear gloves during the sanding operation.
8. After this demonstration, the teacher can proceed with the discussion questions.
9. The teacher will also give a *second demonstration* during the time that students are waiting for their glass squares to be etched. Although the teacher will demonstrate how to separate a glass bottle, the students *will only observe* this operation.

Demonstrating the Separation of a Glass Bottle

10. Locate the position of the glass cutter in jig No. 116-2 so that it makes contact with the bottle to be separated. See Fig. 116-1. In order to induce a fracture, the bottle will be rotated against the cutter wheel. Try and position the cutter wheel so that it will not run over any painted surfaces on the bottle. (Paint on the bottle prevents effective fracturing.)
11. Fasten the glass cutter in place using the straps and screws which have been provided. See Figs. 116-2 and 116-3.
12. Place the bottle in the glass cutting jig and oil the cutter wheel. See Fig. 116-4.

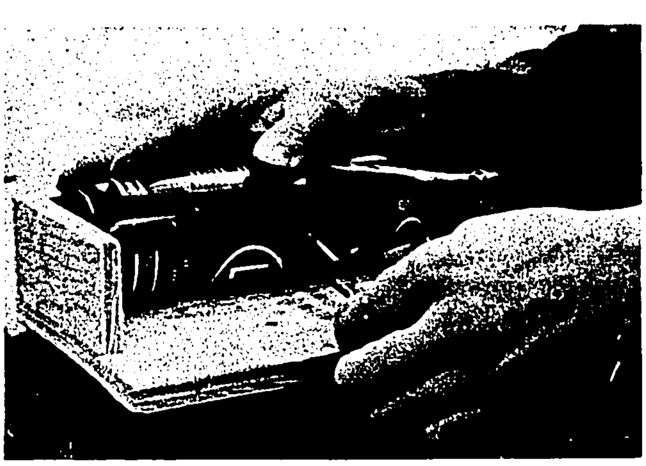


Fig. 116-1. Locating Position for Glass Cutter

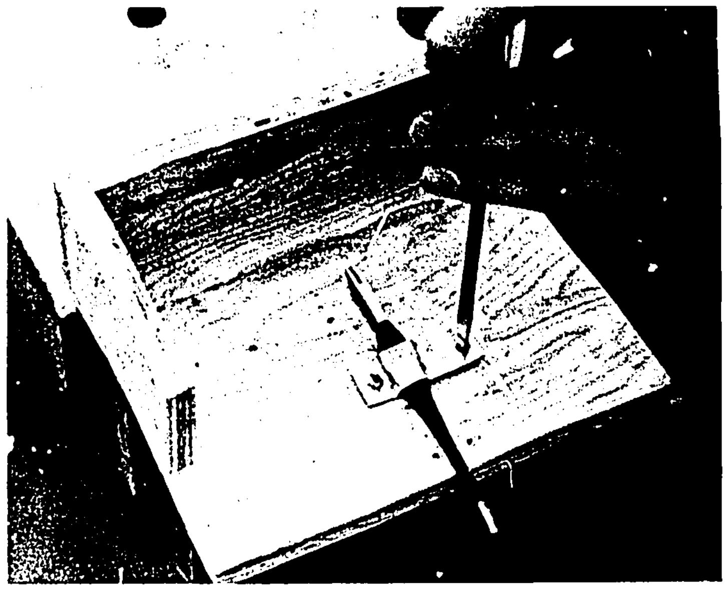


Fig. 116-2. Fastening the Glass Cutter

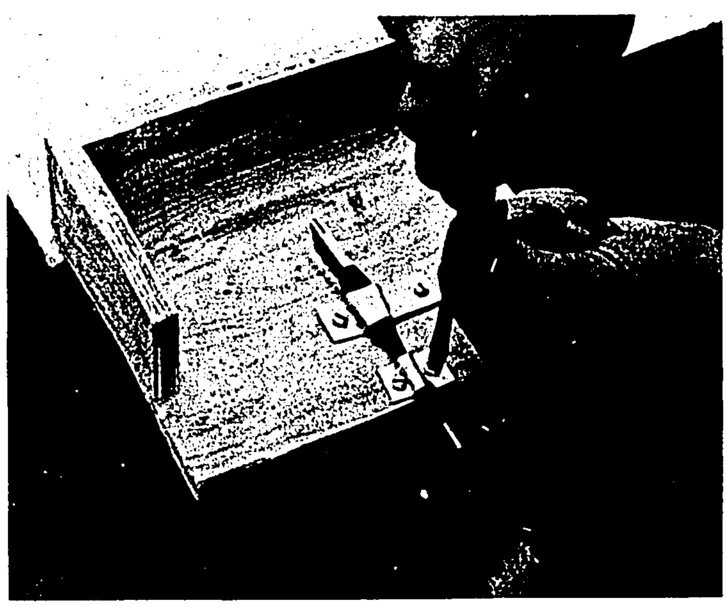


Fig. 116-3. Fastening the Glass Cutter

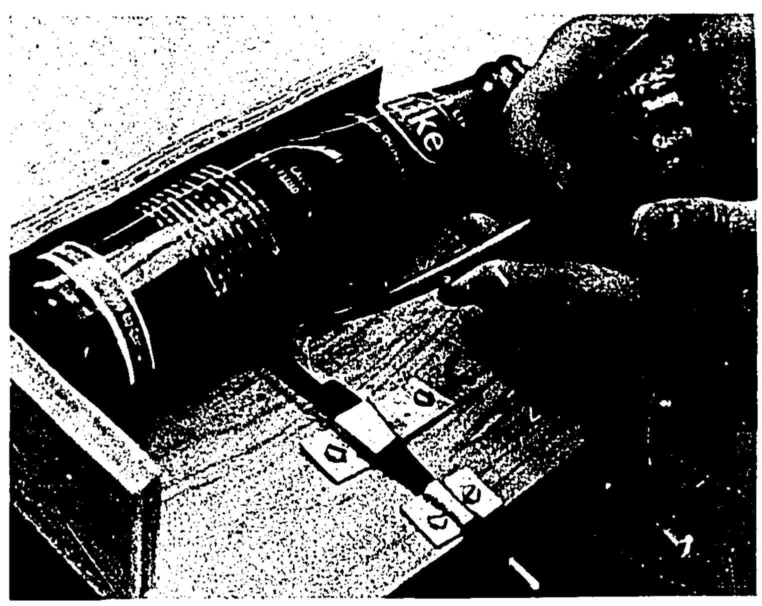


Fig. 116-4. Oiling Glass Cutter Wheel

13. Turn the bottle one complete turn to allow glass cutter to induce the fracture. See Fig. 116-5. To obtain a concentric fracture, keep the bottom of the bottle against the stop while rotating.
14. Once the bottle is completely fractured, sprinkle some water on the surface of the bottle and heat the fractured zone with a propane torch. See Fig. 116-6. Safety glasses and gloves must be worn. CAUTION: *Do not overheat the bottle.*
15. As soon as the drops of water vaporize, immerse the fractured zone of the bottle in a stream of cold water and apply pressure to facilitate separation. See Fig. 116-7.

Fig. 116-7. Cooling Bottle at Fracture

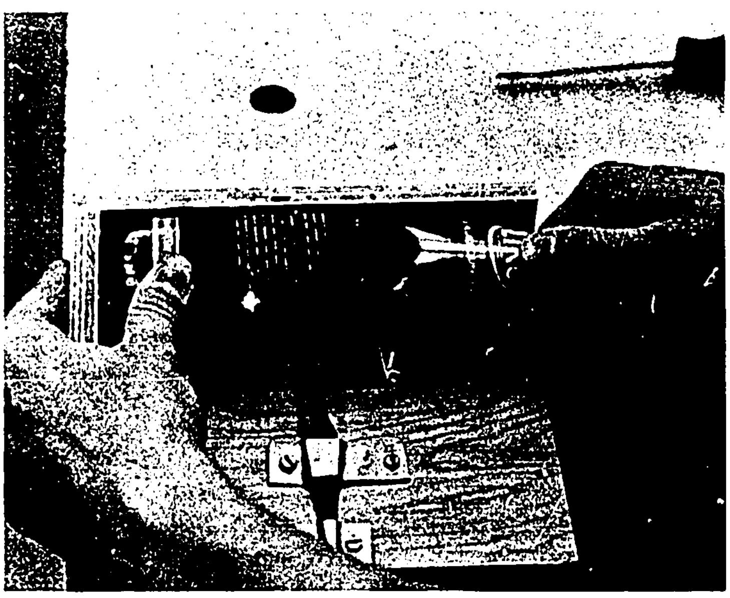


Fig. 116-5. Rotating Bottle to Induce Fracture

Fig. 116-8. Rapid Cooling Causes Bottle to Separate

Fig. 116-6. Heating Bottle at Fracture

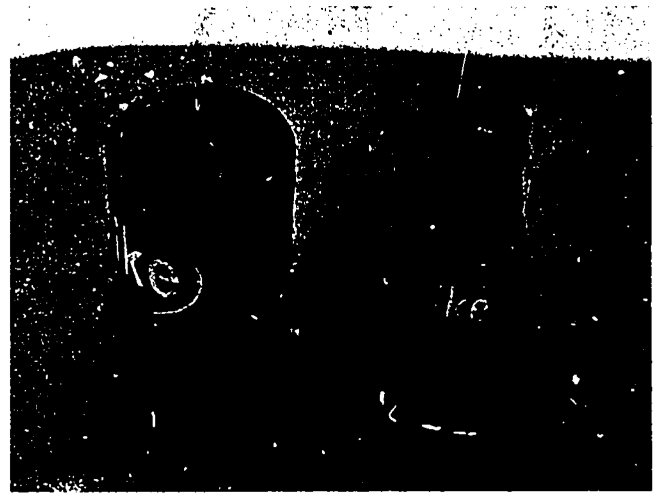


Fig. 116-9. Completed Product

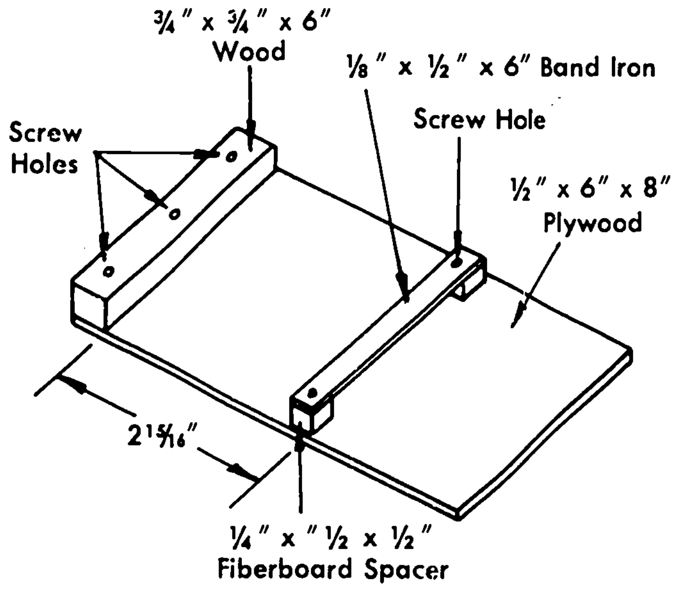


Fig. 116-10. Glass Cutting Jig. No. 116-1

16. Rapid contraction of the glass plus pressure should cause it to separate along the fracture line. See Fig. 116-8.
17. Figure 116-9 illustrates a bottle which has been separated using the above techniques.

Discussion (5)

Review the first demonstration by posing the following questions:

1. Why is it necessary to score glass on a flat, smooth work surface? (Irregularities will prevent a clean score on the glass.)
2. Why must glass be scored for induced-fracture separating in one continuous stroke? (Retracing the scoring line will create a rough fracture line and dull the cutter.)
3. What abrasive material was used to smooth the glass? (Silicon carbide.)
4. At what position is the glass cutter held? (Almost perpendicular to the glass.)
5. How many students assist in inducing a fracture in the plate glass? (Two. One student adjusts the cutting jig while another uses the glass cutter.)

Laboratory Activity (25)

Today the students will separate glass by *induced-fracture* and *chemical separating* processes.

1. The product of today's activity will be a piece of etched glass.
2. Students will work individually, but groups of five will share the equipment and supplies. See Fig. 116-10 for a description of the cutting jig.
3. After the 3″ x 3″ glass square has been sanded, students are to cut out and apply a contact vinyl mask to one side of the glass in the same manner as they did when making the I. D. tags.
4. Caution students to apply the etching cream directly from the tube to the glass. Although this cream will not burn normal skin, it will irritate an open cut.
5. While the glass is being etched, have the students return equipment and supplies not being used, and clean the work area. Adequate etching requires about ten minutes. During this time you can demonstrate separating a bottle using the procedure outlined under "demonstration."
6. Once the glass has been sufficiently etched, students are to wash off the etching cream under cold water.
7. They will then remove the contact vinyl mask.
8. Students should return the etched glass to you for disposal or provide a special container to dispose of glass.

Homework

Review Readings 53 through 56, and 58

Note

Look ahead to Assignment 119, ACTIVITY 65A.

1. Teacher may want to make up additional simple miter boxes for cutoff of doweling to prevent a bottleneck at this operation and also for use in cutting off tenite tips in ACTIVITY 66B.
2. It is recommended that the teacher practice Part 3 of the demonstration to arrive at a proper time and heat ratio for fusing plastic *before* attempting the demonstration.

ASSIGNMENT 117 (OPTIONAL)

Review No. 7

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

Using the summaries of Readings 53-56 and 58, ask and answer questions about material separating, shearing, chip removing, combining components, and separating by other practices.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to do one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking and discussion.
3. Have each group of students get together and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker who is knowledgeable about separating materials to talk to the class. Schedule the speaker for the first class period and tape-record his talk so that it can be played to your other classes.
5. Schedule a field trip to a welding or sheet metal shop.

Homework

None

ASSIGNMENT 118

Test No. 7

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

Given IACP Manufacturing Test No. 7, select the correct responses from a list of items related to concepts presented in Readings 53-56 and 58.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Place the test and answer sheets upside down on each student's desk.
4. At your command, have students turn over the tests and answer sheets.
5. Follow directions as given with the test.
6. Allow 35 minutes for completion; then collect test papers.
7. Review the test with students to provide feedback.

Homework

Reading 61, *Bonding*

Answers to Test No. 7

1. B	2. D	3. A	4. B	5. C	6. D	7. C	8. D	9. A
10. C	11. A	12. B	13. D	14. C	15. B	16. D	17. D	18. B
19. A	20. C	21. A	22. C	23. D	24. B	25. B	26. C	27. C
28. A	29. D	30. A	31. A	32. B	33. D	34. B	35. C	

ASSIGNMENT 119, ACTIVITY 65A
READING 61

Bonding

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using information on bonding:
   a. Identify kinds of products in the home that were fusion-bonded in assembling them at the factory.
   b. Identify kinds of products in the home that were adhesive-bonded before you got them and after you got them.

Laboratory Activity

2. Using the necessary equipment and supplies, cut off and properly lay out the stem for a mallet handle.

Time Schedule

5 Overview
20 Presentation-Demonstration
20 Laboratory Activity

Equipment and Supplies for Presentation-Discussion

Part I

Equipment

1 propane torch w/flame spreader and spark lighter
1 pr. safety glasses
1 pr. asbestos board *or* equivalent
1 pr. combination pliers
1 2″ hand spring clamp

Supplies

2 pcs. 4″ x 4″ 28 ga. galv. *or* tin plate
1 ft. solder wire, acid core
1 btl. flux
1 flux brush

Part II

Equipment

1 propane torch w/flame spreader and spark lighter
1 6″ mill file, bastard cut
1 plastic tote tray

Supplies

1 pc. 2″ x 3″ 28-gage galv. sheet metal
1 pc. asbestos board *or* equivalent
4 pcs. 5⅞″ x 4″ sheet plastic, food wrap material
1 paper cup

Note

The teacher will use equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5 12″ rules
2 8″ mill files, medium grade
1 ball peen hammer, 8 oz.
1 center punch

Supplies (Group of 5)

3 pcs. 4½″ x 5″ abrasive paper, medium grit
1¼ pc. ½″ dia. x 36″ dowel rod

Equipment (Class)

1 miter box w/saw
1 8″ parallel clamp

Overview (5)

1. In manufacturing the house-number marker, you discussed ways of combining components by mixing, coating, *bonding*, and mechanical fastening. Today we will begin the study of *bonding*, one of these four practices.
2. The reading assignment described two basic classes of bonding processes: *fusion* bonding and *adhesive* bonding.
3. Today I will demonstrate bonding by *adhesion* (low-temperature *soldering*, and bonding by *fusion*). I will form a water-tight bag from a thin sheet of plastic material.
4. In the Laboratory Activity, you will begin manufacture of a handle for the mallet. The grip will be *bonded* to the handle by *adhesive* bonding.

Presentation - Demonstration (20)

The teacher will (1) demonstrate soldering, (2) fuse sheet plastic together to form a bag, and then (3) present the directions for the Laboratory Activity.

Part 1, Soldering

1. Review the steps in lighting and extinguishing the propane torch. If soldering coppers are used, explain how they are heated, cleaned, tinned, and used.
2. Demonstrate the proper use of flux in sweat soldering. Scrap materials may be used for this demonstration. Point out that rosin flux is used in electrical work because it is noncorrosive. (This is especially true when aluminum wire is the conductor, because of aluminum's low resistance to corrosion.)
3. Demonstrate soldering two pieces of 28-gage galvanized or tin plate together. Scrap materials may be used. Discuss the differences between low-temperature soldering (*adhesion*) and high-temperature soldering (*adhesion*) and high-temperature soldering (*fusion*). If the class is large, do the demonstration twice, shifting the students around the work area so that all can see as clearly as possible.
4. Place the soldered piece in a vise. Have a student use pliers and attempt to separate the two pieces to demonstrate strength of a soldered connection.
5. Answer any questions about the demonstration.

Part 2, Fusion Bonding

1. Show how the vise-grip wrench is adjusted and how it is locked and released.
2. Remove any rough spots or burrs from edges of a piece of sheet metal by filing and sanding. Then place piece of sheet metal in the vise-grip wrench.
3. Demonstrate how the metal is held while heating (see Fig. 119-1), and how to place the edge of the metal on the plastic to create a bond. Heat the piece of metal for 30 seconds. Then place it on the two plastic squares to create a bond. See Fig. 119-2. *Caution students not to overheat the metal.*
4. Remove the metal strip after 5 seconds, and check the two squares to see if they are fused together. See Fig. 119-3. Ex-

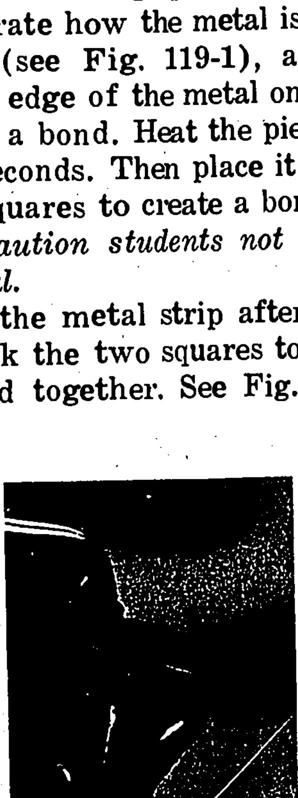


Fig. 119-1. Heating Metal

232

plain to students that the distance between the metal and flame will determine the rate of heating and that once the metal is warm, it does not take as long to reheat. It is suggested that the teacher experiment with the equipment and supplies so he can show the results of proper and improper techniques. If plastic material sticks to metal, cool and sand off.

5. Repeat Operations 3 and 4, varying the heating and fusing time with each repetition.
6. Explain that the two pieces of plastic are both *melted* and *pressed* together only where the hot piece of metal is applied.
7. Test the new plastic bag by filling it with water. See Fig. 119-4.
8. Give examples of plastic products which are bonded by fusion (sandwich bags, meat packaging, plastic models, dry cleaner clothes bag, etc.).
9. Answer any questions about the demonstration.

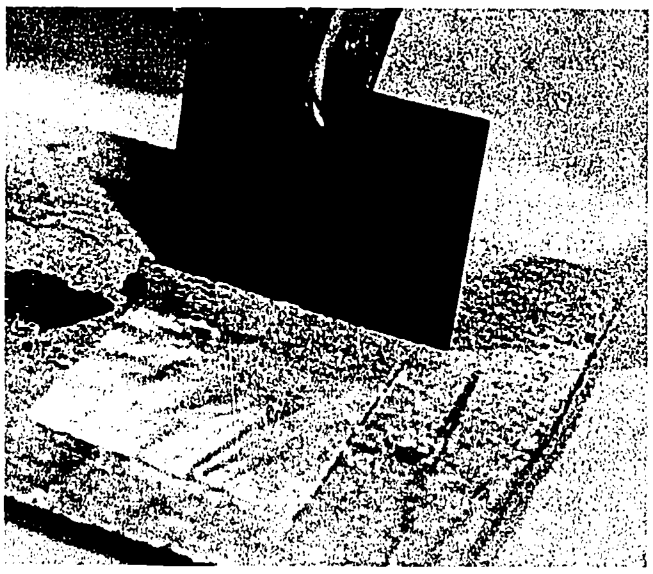


Fig. 119-2. Bonding Plastic

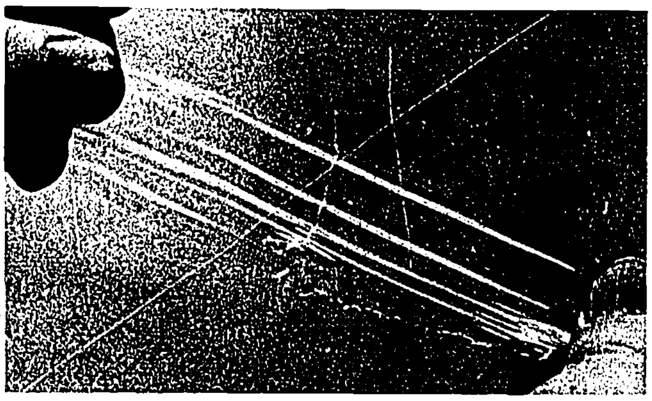


Fig. 119-3. Testing Plastic

Part 3, Separating and Layout

1. Show and name all equipment used.
2. Demonstrate proper use of miter box and stops to cut the $\frac{1}{2}''$ diameter dowel to $9''$ long. Remind students that this is separating by *chip removing*.
3. Demonstrate the use of the file in rounding off one end, and use of sandpaper to touch off other end of dowel. Point out that this is also separating by *chip removing*.
4. Demonstrate with rule and pencil layout of hole, slot, and line for starting the wrap.
5. Answer any questions about layout.

Laboratory Activity (20)

1. Instruct students to *complete* cutoff and layout today.
2. Students will work in regular groups, going to miter box one group at a time. The students will study layout diagram while waiting.
3. Set masking tape stops or parallel clamp on miter box at $9''$.
4. Observe students and provide help when needed.
5. Instruct students to label their workpieces with masking tape at the end of the period.

Homework

None

Note

A recorder should be appointed for marking and storing of tomorrow's product. Also, space should be provided for storage of unfinished mallet handles.

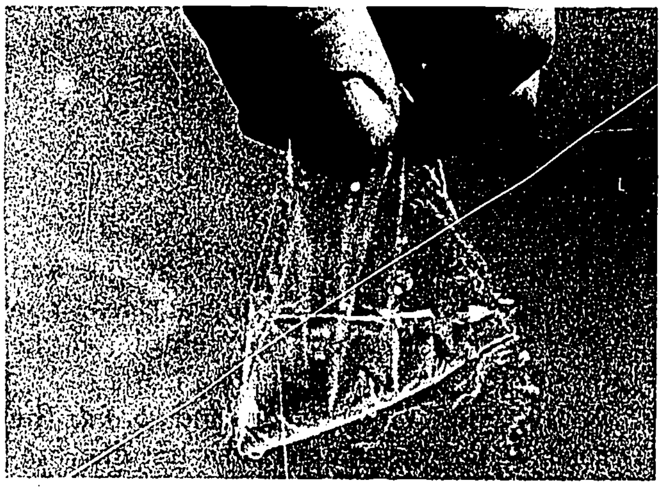


Fig. 119-4. Testing Bag

ASSIGNMENT 120, ACTIVITY 65B

Bonding

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given questions about bonding processes and examples, state the *class* of bonding represented by the four examples.

Laboratory Activity

2. Using the necessary materials and supplies, fabricate and combine the components to complete a handle acceptable for mounting a soft-faced mallet.

Time Schedule

5 Overview
10 Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1	hacksaw
1	hand drill
1	9/64″ twist drill
1 pr.	scissors
1	brush, paste
1	yardstick

Supplies (Group of 5)

1 btl.	white glue
25 ft.	1/8″ sash cord
1 roll	masking tape
1	paper towel

Overview (5)

1. Yesterday you saw demonstrations and discussed various *bonding* practices. You then cut off the stem and completed the layout for the mallet handle.
2. Today you will prepare and *bond* the components to complete the handle *subassembly*. You will then store the handle for later *coating* operations.
3. You will use knowledge gained from the lesson to answer questions in the Laboratory Manual about *bonding*.

Demonstration (10)

1. Show and name equipment used.
2. Demonstrate cutting the slot for the wedge with a hacksaw. Remind students that this is a form of chip removing.
3. Demonstrate use of hand drill to drill a 9/64″ hole. Remind students that this also is chip removing.
4. Demonstrate positioning of frayed end of cord on dowel rod at line and wrapping of cord back down the handle to the hole. Do this without glue, but remind students to apply glue before wrapping so that *bonding* will take place. Remind them also to maintain a *consistent* tug on the cord as they wrap it.
5. Put cord through hole and place tape over end of cord to show students how it will be held in place for *bonding* while stored.

Discussion (5)

1. What kind of *bonding* was used to combine the two pieces of metal in the demonstration yesterday? (Adhesive bonding.)
2. What kind of *bonding* was used to make the plastic bag in yesterday's demonstration? (Fusion bonding.)
3. How are the two bonds different? (Solder is used to hold the metal surfaces together; the plastic is melted and fused together.)
4. What kind of *bonding* is used to bond the cord to the stem in today's activity? (Adhesive bonding.)

Laboratory Activity (25)

1. Students are to follow instructions given during the demonstration and in the Laboratory Manual.
2. Although not critical, caution students to keep the 9/64″ drill at right angles to the axis of the dowel when drilling.
3. Have students practice wrapping approximately 1″ of the handle before applying glue. This will familiarize them with that operation.
4. To utilize available tools, the teacher may want to have two students in each group start on Step 3, *drilling*; two on Step 4, *sawing;* and one on Step 5, *cutting cord.* Rotate students through these steps.

Safety Precaution

Safety supervisors are to make sure safety glasses are worn by students while drilling.

Homework

Review Reading 55, *Chip Removing*

Note

Look ahead to Assignment 127, 128. If plexiglass is used for tool tray handle, teacher should precut pieces to ¾″ width for ACTIVITY 70A-G.

Answers for Laboratory Manual

1. fusion, adhesive
2. adhesive
3. (a) F
   (b) A
   (c) A
   (d) A
   (e) F
   (f) F
   (g) F

ASSIGNMENT 121, 122
ACTIVITY 66A, B
REVIEW READING 55

Chip Removing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given a demonstration, equipment, and supplies, manufacture the components necessary to assemble a soft-faced mallet head.

Time Schedule

Assignment 121
5 Overview
20 Demonstration
20 Laboratory Activity

Assignment 122
5 Overview
40 Laboratory Activity

Equipment and Supplies for Laboratory Activities

The teacher will use the equipment and supplies needed for Problems 1-5 to demonstrate the procedures students will follow.

Problem 1

Equipment (Class)

1	drill press
1	½″ twist drill
2	holding jig No. 121-1
1	Guide A for jig No. 121-1 for marking
1	Guide B for jig No. 121-1 for drilling
1	taper pin reamer No. 2 or No. 9
1	metalworking vise
1 pr.	vise jaw guards
1	brace, wood
1	center punch

Supplies (Class)

25	component 55D, mallet head casting

Problem 2

Equipment (Class)

2	10″ mill file, coarse
1	file cleaner
1	electric hand drill
1	13/64″ twist drill
1	tap wrench
1	¼″-20 bottom tap
1	drill jig No. 121-2
1	tapping jig No. 121-3

Supplies (Class)

1 roll masking tape

Problem 3

Equipment (Class)

2	vise
2 prs.	vise-jaw guards
2	hacksaw
2	10″ mill file, smooth
2	6″ adjustable wrench
8	¼″-20 hex nuts

Supplies (Class)
1 roll masking tape
40″ 1/4″-20 threaded rod

Problem 4

Equipment (Class)
1 miter box w/saw
1 parallel clamp

Supplies (Class)
12 4 1/2″ x 5 1/2″ abrasive paper, fine grit
40″ 7/8″ dia. tenite rod

Problem 5

Equipment (Class)
2 hand drill
2 13/64″ twist drill
2 vise, metalworking 4″
2 prs. vise-jaw guards
2 1/4″-20 tap, bottom
2 tap wrench
1 drill jig No. 121-4
1 tapping jig 66A-6 No. 121-5

Supplies (Class)
25 7/8″ x 1 1/2″ tenite rod, from Problem 4

Problem 6

Equipment (Class)
1 miter box w/saw, used in Problem 4
2 10″ file, mill, smooth
1 file cleaner
1 parallel clamp, used in Problem 4

Supplies (Class)
12 4 1/2″ x 5 1/2″ abrasive paper, fine grit
25 7/8″ x 1 1/2″ tenite rod, from Problem 5

Note

All equipment should be available at the respective work stations. The student groups will rotate through the work stations upon the teacher's direction.

Overview (5) Assignment 121

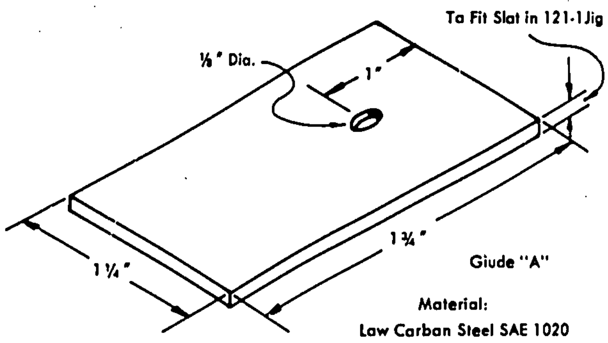
1. Yesterday you *applied* your knowledge of bonding practices by bonding the grip to the mallet handle. Today you will utilize various *chip removing* practices to manufacture the components for the mallet head.
2. I will give you demonstrations on some of the operations that you will perform in making the components.
3. You will drill and taper the hole in the head for the handle.
4. You will drill and tap the holes in the head for the studs.
5. You will cut the studs to length and dress the ends.
6. You will cut, drill, and tap the tenite tips.
7. Steps 1-6 will be a two-day activity.

Overview (5) Assignment 122

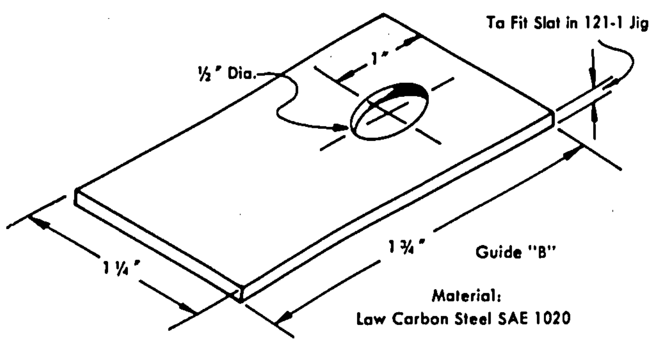
1. Yesterday you began making the components for the mallet head, utilizing various chip removing practices. Today you will complete these components.

Demonstration (20) Assignment 121

1. You will recall from the presentation on chip removing when you made the house number marker that *chip removing* is one basic way of separating materials. It involves removing small amounts of material in the form of chips, shavings, sawdust, or similar small bits. The tool may have one cutting edge or several. To shape the material, the chip removing tool must be harder and tougher than the material. In making the mallet head you will be utilizing the chip removing practices of *drilling, reaming, tapping, filing,* and *sanding.*
2. Before the handle hole is drilled in the mallet head, it should be center punched to insure that the drill will start in the proper spot. Use the marking jig shown in Fig. 121-1A to locate this spot. Demonstrate center punching.
3. At work station No. 1, drilling guide 121-1 should be clamped to the drill press table to further insure that the hole will be drilled in the proper place. Be sure to seat the component securely in the jig. Demonstrate drilling the 1/2″ hole. Use drill guide 121-1B, Fig. 121-1B.
4. The taper in the top of the hole will allow you to slightly spread the top of the handle to lock it into the head. Demonstrate tapering the hole.
5. At work station No. 2, you will drill and tap the holes for the connecting studs. These must be straight to insure a correct fit between the plastic tips and the metal head. Drilling and tapping jigs, Fig. 121-2, will help you keep the drill and the tap straight. Demonstrate drilling and tapping the holes. Caution stu-



A. Drill Guide Marking Jig



B. Drill Guide

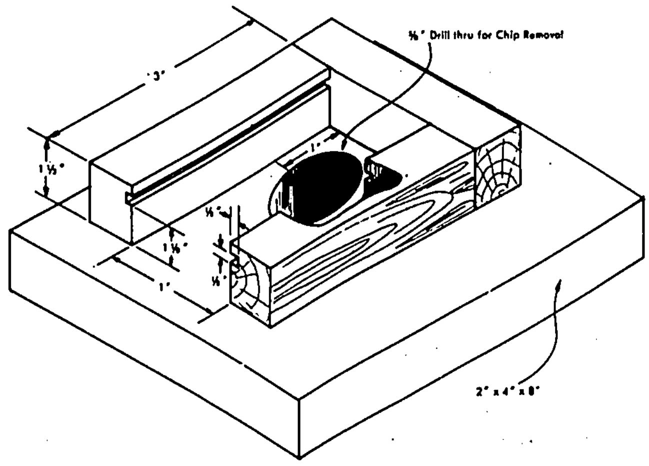


Fig. 121-1. Holding Jig

dents *not to force* a tap. If it binds, they are to get help from the teacher.

6. At work station No. 3, you will cut the studs and dress the ends with a file. Demonstrate cutting the studs and dressing the ends. Explain that by putting nuts on the threaded rod the threads can be protected and damaged threads can be rechased.
7. You will cut off and dress up the stock for the tips at work station No. 4. Demonstrate cutting plastic rod with miter box and sanding cut ends.
8. At work station No. 5, you will drill and tap holes for the studs using jigs, Fig. 121-2, to insure that they are straight. Notice that you can actually see the threads being cut through the clear plas-

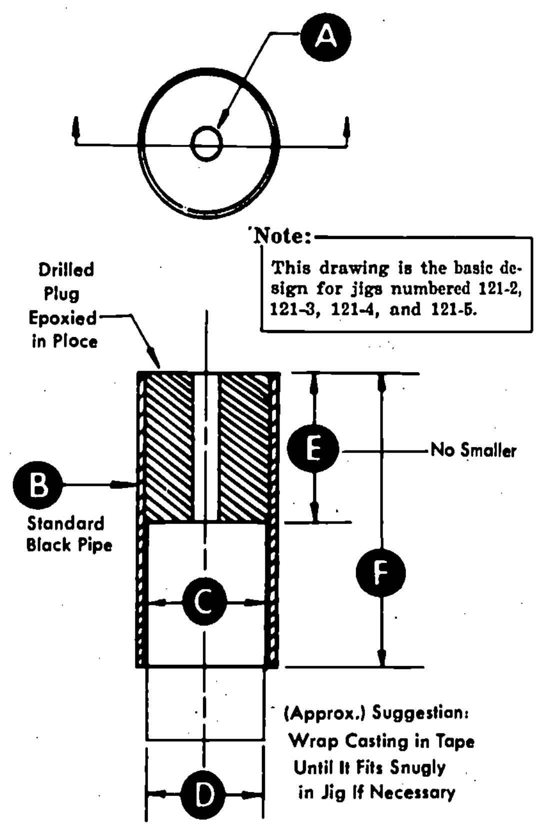


Fig. 121-2. Drilling Tapping Guides for Mallet Head and Tips

Drill Jig No. 121-2 for Mallet Head	Tapping Jig No. 121-3 for Mallet Head	Drill Jig No. 121-4 for Mallet Tips	Tapping Jig No. 121-5 for Mallet Tips
A. #6 Drill *or* $3/16''$	A. "F" Drill *or* .257″	A. #6 Drill *or* $3/16''$	A. "F" Drill *or* .257″
B. 1″	B. 1″	B. ¾″	B. ¾″
C. $1\frac{1}{32}''$ I.D.	C. $1\frac{1}{32}''$ I.D.	C. .880 I.D.	C. .880 I.D.
D. $31/32''$ (See note)	D. $31/32''$ (See note)	D. ⅞″ (.875)	D. ⅞″ (.875)
E. 1″ (Hold)	E. 1″ (Hold)	E. 1″ (Hold)	E. 1″ (Hold)
F. 2″	F. 2″	F. 2″	F. 2″

tic. Indicate to the students that, generally speaking, in order for threads to secure components adequately, the depths of the *effective* thread should be at least 1½ times the diameter of the stud or bolt. Give them an example. Demonstrate drilling and cutting the threads.

9. When everyone has cut the plastic stock to the 1½″ length, the miter box stop will be reset and this will become work station No. 6. The drilled and tapped plastic rod will be cut in half and sanded smooth to form the tips for the mallet head. Demonstrate cutting, filing, and sanding the tips.

Laboratory Activity (20) Assignment 121

1. Assign students to three groups of six, one group of seven.
2. Start one group each at work stations 1, 2, 3, and 4.
3. As groups come to the teacher to have the components checked, the teacher will assign them to a new work station until each group has rotated through all six stations.
4. Caution students to perform drilling and tapping operations *carefully* so that jigs are not damaged and that components will *fit properly* when they are combined.
5. *Stress* that students will leave all tools *at* a work station before they rotate to a new station.

Laboratory Activity (40) Assignment 122

1. Continue work started yesterday until all problems have been completed.
2. Remind students to label completed parts with masking tape and store them for use in Assignment 124.

Safety Precautions

1. Use safety glasses when drilling.
2. Do not force a tap if it binds.
3. Keep hands clear of saw when holding plastic rod for cutting in miter box.

Homework

Reading 69, *Coating*

Note

In preparation for Assignment 124, the teacher should try to gather a variety of threaded and nonthreaded examples as *suggested* for the presentation-demonstration.

ASSIGNMENT 123, ACTIVITY 67 READING 60

Coating

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on coating:
   a. Name some products other than fire extinguishers and school buses having coatings that transmit information.
   b. Look at a store display and name products that have been coated for eye appeal, and for protection.

Discussion

2. Given questions about coating materials:
   a. Describe applied coating and conversion coating.
   b. Name six applied-coating practices.
   c. Name one conversion-coating practice.
   d. Name three classifications of coating materials.

Laboratory Activity

3. Using component 65B, hammer handle:
   a. Spray-coat one-half of the handle with spray enamel.
   b. Dip corded portion of the handle to coat and bond the grip.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

2 prs. scissors
2 X-acto® knives

Supplies (Group of 5)

5 pcs. duplicator paper
1 can rubberized vinyl, 13 oz.
1 can enamel spray, at spray booth

Overview (5)

1. The last two assignments have involved the practice of chip removing while making the head to the mallet. Today you will complete the handle.
2. In today's reading assignment you learned about the various types of coatings and their application.
3. Today I will tell you about the two main coating processes.
4. You will be asked to give examples of both types of these coatings.
5. In today's activity you will use spraying and dipping techniques in coating the mallet handle.

Presentation (10)

1. Coating processes are of two basic kinds: *applied coating* and *conversion coating.*
2. Most coatings are "applied." In the applied-coating process a second material is bonded or adhered to the main component.
3. Coatings of the organic type (such as paint) are usually applied by *brushing, rolling, dipping,* or *spraying.*
4. One of the newest techniques for applying paint is *electrostatic* spraying. Droplets of paint are given a positive electrical charge and the workpiece is grounded. The charged coating particles are electrically attracted to the workpiece. Using this technique, very little spray is lost and the coating is uniform in thickness.
5. *Electroplating* is an applied-coating process which involves coating one metal with another. Examples of electroplating metals are chromium, nickel, gold, silver, copper, and tin.
6. *Conversion* coating is a process in which a material can be made to produce its own coating by changing the surface layer of the workpiece itself. *Anodizing* is a conversion-coating process used with aluminum.
7. You should recall from a previous presentation that there are three types of coating materials: *organic, inorganic-nonmetallic,* and *inorganic metallic.*

Discussion (5)

1. In applied processes of coating, what happens to the object being coated? (A second material is being bonded or adhered to it.)
2. In the *conversion* processes of coating, what type of reaction takes place on the surface of the object being coated? (Chemical.)
3. Give an example of a *conversion*-coating process. (Anodizing.)
4. Name six *applied*-coating processes. (Rolling, brushing, dipping, spraying, printing and plating.)
5. Is the printed poster an example of applied or conversion coating? (Applied.)
6. *Organic, inorganic-nonmetallic,* and *inorganic-metallic* are three classes of coating materials. Identify an example of each of the classifications. (Organic — paint or varnish; inorganic-nonmetallic — vitreous enamel such as sinks or bath tubs; inorganic-metallic — copper plating or cadmium plating.)

Laboratory Activity (25)

Today the students will *spray-coat* and *dip-coat* the hammer handle.

1. Arrange temporary storage for drying handles. Punch holes in a cardboard box to hold them while drying.
2. Make a shield out of a sheet of paper. Locate the center of the paper and cut a ½″ diameter hole.
3. Insert the handle through the paper until it rests on the corded part of the handle.
4. Spray-paint this section of the handle with a fast-drying enamel. Allow the handle to dry before removing the paper mask.
5. When the sprayed section of the handle is dry, dip the corded portion of the handle in vinylized rubber. Latex paint is a suitable substitute.
6. The recorder stores the handle until final assembly.

Homework

Reading 62, *Mechanical Fastening*

ASSIGNMENT 124, ACTIVITY 68
READING 62

Mechanical Fastening

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about mechanical fastening:
   a. Look at a toaster, mixer, blender, or some other small appliance, and name the kinds of fasteners used in one of the products.
   b. Name three products in the home that have been fastened by: nails and staples, threaded devices, and lacing.

Discussion

2. Given five questions:
   a. Name two basic classes of mechanical fasteners.
   b. Name the force which mechanical fasteners use to hold components together.
   c. Explain how components can be mechanically fastened together without using separate fasteners.
   d. Name two ways in which the coarseness or fineness of threads affects usage.

Laboratory Activity

3. Using the necessary equipment and supplies, fabricate and combine components to make a soft-faced mallet by using threaded and nonthreaded fasteners to assemble the components.

Time Schedule

5 Overview
15 Presentation-Demonstration
10 Discussion
15 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

Equipment

1 hand seamer
1 7 oz. claw hammer

Gather as many examples as possible of the following:

Threaded Mechanical Fasteners

1. largest and smallest nut and bolt
2. pipe threads or fittings, any size
3. jar and lid, glass or metal
4. light bulb and/or socket
5. wire nut, solderless connector
6. 2 pcs. aluminum, 3″ x 5″

Nonthreaded Mechanical Fasteners

1. tire weight
2. flat metal strapping, banding
3. hinges, loose pin butt hinge
4. plastic wall anchor
5. paint spray with snap-cap
6. large rubber band
7. paint can lid
8. nail, tack, spike

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

2 7 oz. claw hammers
1 adjustable wrench, 6″
2 ¼″-20 hex nuts

Supplies (Per student)

5 cast mallet head
5 9″ handle for mallet
10 tenite tips
10 ¼″-20 x ¾″ studs
5 No. 4 corrugated fastener, ½″

Overview (5)

1. Yesterday you performed a coating operation on your mallet handle.
2. Your reading described how various types of components can be mechanically fastened.
3. Today I will demonstrate a few examples of mechanical fastening.
4. You will be asked to answer questions about threaded and nonthreaded fasteners.
5. During today's laboratory activity you will complete final assembly of your mallet by mechanical fastening.

Presentation - Demonstration (15)

1. All mechanical fastening uses *friction* or some kind of mechanical force to hold components together.
2. All mechanical fasteners can be put into

two separate classes: threaded and nonthreaded.

3. A threaded fastener is one that has screw threads either inside or outside a central core or body; for example, screws, nuts, and studs.
4. Teacher should show examples of threaded fasteners such as:
   a. comparing largest and smallest bolt and nut
   b. pipe threads
   c. jar and lid threads
   d. light socket and bulb
   e. tube compression fittings, plumbing
   f. wire connectors to join pieces of electrical wire
5. Threaded assemblies, nuts and bolts are held together by a resistance or force called *friction.* The number of threads per inch determines the holding efficiency of the fastener. The more threads per inch, the greater the holding power. The reason behind this is that more threaded surface allows for *more friction* between mating parts.
6. A thread that is cut outside a rod or shaft is an *external* thread; for example, a bolt.
7. A thread that is cut inside a hole is an *internal* thread; for example, a nut.
8. Many nonthreaded fasteners are fabricated as part of a component. Demonstrate bending and fastening two pieces of sheet metal with a lapped seam, using a hand seamer. See Fig. 124-1. If the assembly is to be permanent, it can be crimped together; demonstrate hammering seam together with a mallet.
9. Demonstrate fastening two pieces of paper by folding upper corner, tearing a tab, and folding. Point out no additional fastening device was added to the original components. See Fig. 124-2.
10. Show examples of *nonthreaded* fasteners such as:
    a. tire weight
    b. flat metal strapping
    c. hinges
    d. plastic wall anchor
    e. paint spray can with snap-cap
    f. rubber bands
11. Demonstrate the use of hex nuts in fastening the studs into mallet head.
12. Demonstrate how to use corrugated fastener to fasten mallet head on handle.

Discussion (10)

1. Name the two classes of *mechanical fasteners.* (Threaded, nonthreaded.)
2. What *force* is used when mechanical fasteners hold components together? (Friction.)
3. Name two ways in which the *coarseness* or *fineness* of threads affects usage. (Most machinery uses fine threads where vibration is a factor. Most coarse threads are used where vibration is not a factor or where precision is not so critical.)
4. Give 10 examples of threaded mechanical fasteners.
   a. nuts
   b. bolts
   c. pipe fittings
   d. light bulb
   e. light socket
   f. sheet-metal screws
   g. wood screws
   h. threaded pipe-tube connectors
   i. jar lid
   j. jar

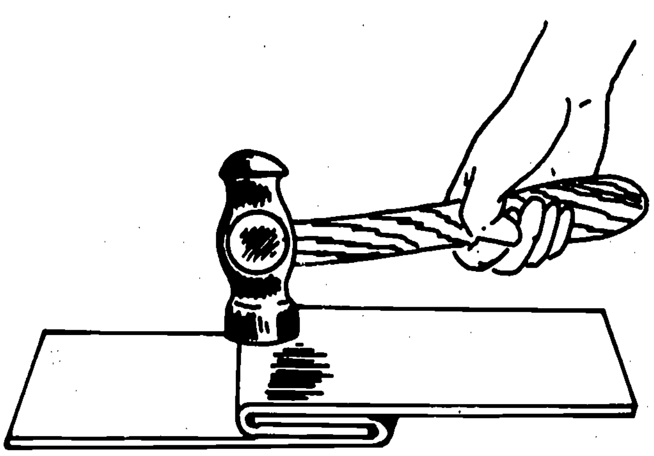


Fig. 124-1. Fastening Sheet Metal

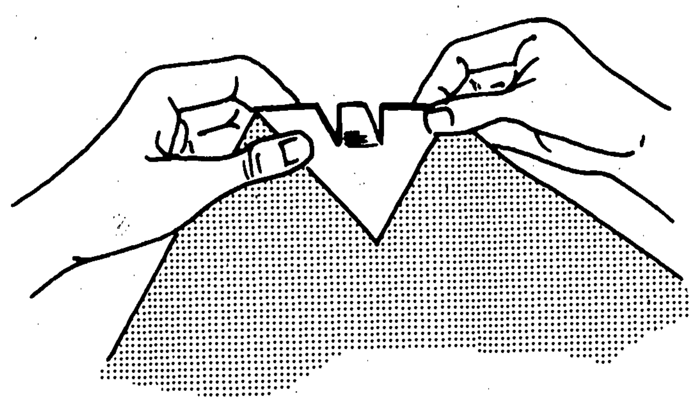


Fig. 124-2. Fastening Paper by Bending and Folding

5. Give 10 examples of nonthreaded fasteners.
   a. staple
   b. nail
   c. twine
   d. lacing
   e. safety pin
   f. zipper
   g. rubber band
   h. tire weight
   i. snap-cap
   j. hinge

Laboratory Activity (15)

1. Have students assemble in their group. Each student should have all components for mallet head assembly.
2. Fasten mallet head to handle with corrugated fastener.
3. Make sure threaded hex nuts and wrench are used to tighten studs into mallet. Remove hex nuts after stud is in mallet head. See Fig. 68-3.
4. Thread tenite tips onto studs to complete mallet.
5. Have students answer Laboratory Manual questions and complete Fig. 68-5, Process Checklist (Mallet).

Homework

Reading 59, *Mixing*

Answers for Laboratory Manual

1. Threaded, nonthreaded
2. Studs
3. Tapping
4. Friction
5. Coating
6. Nut, bolt, jar, lid, socket, wire nut
7. Nail, tack, spike, rubber band, hinge
8. Fig. 68-5, Process Checklist (Mallet)
   1. One-shot molding (part head)
   4. Sawing, filing, drilling (head, handle)
   5. Cutting with knife (rope)
   8. Adhesion, glueing (rope to handle)
   9. Threading, wedging (tips to head) (handle to head)
   10. Spraying, dipping (handle) (handle grip)

Note

1. Look ahead to Assignment 136. You will need to buy good bulbs and run 9 volts through them to make bad bulbs.
2. You will need to run down some of the batteries.
3. See the drawing of the continuity tester for help in assembling the kit. See Fig. 136-1.

ASSIGNMENT 125, ACTIVITY 69
READING 59

Mixing

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on mixing:
   a. Give some examples of the mixing of two solids, and the mixing of two liquids that take place in the home.
   b. Give some examples of the mixing of solid with a liquid, and the mixing of a gas and a liquid that take place in the home.

Discussion

2. Given questions, state some examples of products that are manufactured by mixing and state the mixing technique used to manufacture each example.

Laboratory Activity

3. Using the necessary equipment and supplies, manufacture an expanded foam sponge to simulate industrial practices of mixing and forming by conditioning materials.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

3 12″ rules
1 stapler w/staples

Supplies (Group of 5)

5 plastic sandwich bags
5 3-oz. paper cups
5 stirring sticks

Supplies (Per student)

½ oz. prepolymer *A* and catalyst *B*, flexible polyurethane foam components

Overview (5)

1. You have been studying techniques for combining components into subassemblies or products. In today's assignment you will be introduced to various ways of combining components by *mixing*.
2. The text lesson described mixing practices in industry. I will review briefly some of the practices and equipment used in industry for *mixing*.
3. You will be asked to name products that are mixed, and types of mixing operations.
4. You will manufacture a flexible foam "sponge", using mixing operations similar to those used in industry.
5. You will answer and discuss questions concerning the mixing practices done in the laboratory activity.

Presentation (5)

You have studied three basic ways to combine materials. They are coating, bonding, and mechanical fastening. We will now discuss the fourth basic combining practice.

1. Mixing is the fourth basic way to *combine materials.*
2. Two gases, two liquids, or two solids can be mixed together, gas/gas, liquid/liquid, solid/solid; or gases, liquids, and solids can be mixed in any combination.
3. Mixing practices in industry include *stirring, tumbling, mulling,* and *kneading.*
4. Equipment used includes propellers, beaters, pumps, shakers or vibrators, tumblers, pressure tanks and valves.
5. If a *chemical reaction* occurs when ingredients are mixed, the mixture will have new qualities or properties.

Discussion (5)

1. Name some products whose ingredients were mixed by *tumbling.* (Answers will vary: concrete, headache pills, etc.)
2. Name some mixing practices that might require *heat.* (Answers will vary: alloying steel, mixing sugar into soft drinks, blending candy, etc.)
3. Name some products that are mixed by *stirring.* (Paints, soft drinks, gasoline additives, etc.)
4. In what three physical *forms* do ingredients or materials exist? (They can be gases, liquids, or solids.)

Laboratory Activity (30)

Note

a. In advance of this assignment, the teacher should measure ½ oz. of water into one of the cups he receives for this activity to determine where student will place the first mark inside the cup in Step 2 of the Laboratory Activity. Then repeat with 1 oz. of water for Step 3 of Laboratory Activity. The results of this should then be placed on the chalkboard for the students to copy.

b. In pouring ingredients, it will be easier to control if teacher pours *A* and *B* from cans into separate large cups and then pours from them into students' cups.

1. Students will work in their regular groups of five.
2. Distribute equipment and supplies, except the ingredients for the urethane foam. Dispense these to each student when he is ready.
3. Foam ingredients must be mixed thoroughly if the reaction is to take place.
4. Observe students and provide help when needed.
5. Allow time for discussing answers to Laboratory Manual questions while foam is "setting."
6. Store "sponges" for removal of plastic bags tomorrow.

Safety Precautions

1. Caution students not to spill foam ingredients on clothing.
2. Caution students not to breathe fumes.
3. Do not pour foam ingredients into sink or drain.

Homework

Review Reading 53, *Material Separating Practices*

Note

Look ahead to Assignment 134 and start to gather packages needed to conduct activity for *Preparing for Distribution.*

Answers for Laboratory Manual

1. Stirring
2. Liquid
3. High
4. The mixture would not foam or expand
5. Chemical reaction
6. Yes

ASSIGNMENT 126, ACTIVITY 70A-G
READING 63

Combining Subassemblies

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using information about combining subassemblies:
   a. Identify products in the home or school that were made by *batch* and by continuous assembly.
   b. Give reasons why women can do some assembly jobs better than men.

Discussion

2. Given a presentation on combining subassemblies:
   a. State how components are formed into subassemblies.
   b. Name the two major types of assembly.
   c. Name four examples of products assembled by batch or lot assembly.
   d. Name four examples of products assembled by continuous or line assembly.

Laboratory Activity

3. Using a drawing of a specific product:
   a. Analyze the product and determine the components to be manufactured and the possible materials and processes necessary for its manufacture.
   b. Complete a route sheet for a single component.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 Transparency 126, *Route Sheet*

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1	squaring shear
2	scratch awl
1	8″ file, mill
1	template No. 126-1, See Fig. 126-4
1	template No. 126-2, See Fig. 126-5
1	drill fixture No. 126-3, See Fig. 126-10
1	locating die No. 126-4A and B. See Fig. 126-7
6	8 oz. ball peen hammer
2	center punch
1	box and pan brake
2	miter box w/saw
1	orbital sander
1	drill press
4	aviation snips
2	1/8″ hand punch
1	hand drill
1	metalworking vise
2 sets	pop rivet gun
1	bench knife
1	hacksaw
1	11/64″ twist drill
1	3/16″ twist drill
1	12″ rule
1	10″ file, mill
1	10″ file, smooth
6	screwdriver
2	4″ x 6″ wood block
1 pr.	paper cutter or scissors
1	small brush
1	cardboard box, spray booth
1	felt-tip pen
5	2″ Handy® spring clamp

Supplies (Per student)

1 pc.	tin plate 14″ x 20″, 30 ga.
1 pc.	wood 1/2″ x 3 5/8″ x 12″
1 pc.	polyethylene, .060 thickness 1/2″ x 5″
1 pc.	acrylic plastic 1/4″ x 3/4″ x 6″ clear
1 pc.	acrylic plastic 1/4″ x 3/4″ x 6″ opaque
2	nails, 10d common
8	screws, No. 4 x 1/2″ PH sheet metal
7	pop rivets, 1/8″ dia., 1/8″ length
1	pop rivet, 1/8″ dia., 1/4″ length
2 shts.	aluminum oxide, abrasive paper No. 120 grit
1 can	spray paint, any color
5 shts.	duplicator paper
1 qt.	ethylene dichloride
1 qnty.	epoxy glue
5 shts.	silicon carbide, wet-dry abrasive paper, medium grit

Overview (5)

1. In the past few weeks you have learned that a single part, called a *component*, is manufactured by separating and/or forming. You have also learned that components are frequently combined with other components.
2. Today I will tell you about combining components into subassemblies.
3. You will be asked to name four ways of combining components.
4. During the next few activities we will be manufacturing a product, a utility box, made of subassemblies. You will specialize in one area of production. Today we will plan our production.

Presentation (10)

1. Components are combined by mixing, coating, bonding, and mechanical fastening.
2. These practices are used to form subassemblies or to combine subassemblies into more complex, finished products.
3. There are two major types of assembly arrangements:
   a. Batch or lot assembly.
   b. Continuous or line assembly.
4. *Batch or lot assembly* is frequently used if only a few units of the product will be sold or if the demand is seasonal. Batch assembly is also used to manufacture products that require mixing of components in batches. Examples of products manufactured by batch or lot assembly methods are photographic film, aspirin tablets, soft drinks, concrete, many food products, and clothing. Batch or lot assemblies, for example, may be produced in groups of five, ten, or whatever number is convenient for production purposes.
5. Continuous or line assembly is used when a uniform product is manufactured continuously. Examples of products manufactured by continuous or line assembly

are automobiles, motorbikes, telephones, television sets and other electronic equipment.

6. On continuous or line assembly, men and machines work together to *position* and *fasten* components and subassemblies into place on some type of production line. The result of positioning and fastening will be a manufactured product assembled in a short period of time by many workers. Each worker performs a specialized job at a specific work station.
7. Continuous or line production is most efficient and least expensive when many units of the same product are being manufactured.

Discussion (5)

1. How are components combined into subassemblies? (By mixing, coating, bonding, and mechanical fastening.)
2. What are the two major types of assembly? (Batch or lot assembly and continuous or line assembly.)
3. Name four examples of products assembled in batches or lots. (Clothing, food products, concrete, soft drinks.)
4. Name four examples of products assembled by continuous or line assembly methods. (Automobiles, telephones, television sets, refrigerators.)

Laboratory Activity (25)

In today's activity the students will plan for the production of the utility box. The next five or six activities allow for production.

1. Direct students to analyze the drawing, Fig. 126-1. (Fig. 70A-1 in their Laboratory Manual.)
2. Ask students to identify the components. List these on the chalkboard. Have students write nomenclature on their Fig. 70A-2.
3. Ask students to identify possible materials for each component.
4. Have students analyze one component, the bottom. What processes must take place to change the standard stock into the component? List processes in random order on the chalkboard.
5. Ask students to arrange the processes in correct order. Record their responses on Transparency 126, *Route Sheet.*
6. Have students complete the Laboratory Manual counterpart of Parts List, Fig. 126-3 and the Route Sheet, Fig. 126-1 as you complete the transparency. Fig. 126-3 is L.M., Fig. 76A-2) (Fig. 126-1 is L.M., Fig. 76A-3.)

Homework

None

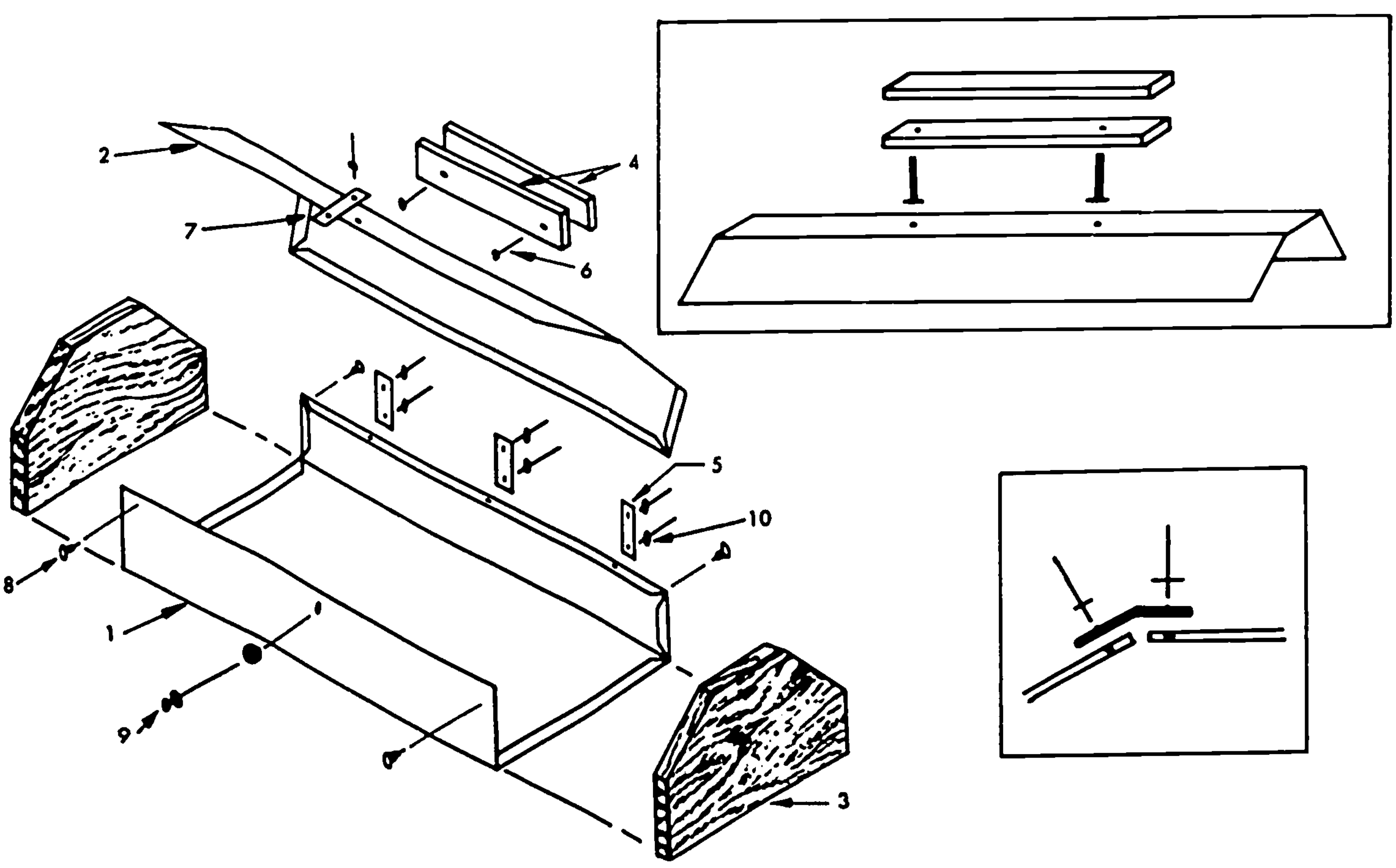


Fig. 126-1. Exploded View of Utility Box

Fig. 126-2. Route Sheet

Part Name *Bottom* Part No. *1* Material *Tin Plate*

Component ☒

Subassembly ☐

Final Assembly ☐

Number of Pieces Needed Per Assembly *1*

Stock Size *14 X 20*

Operation Number	Description of Operation	Machine	Tools, Jigs	Supplies
1	*Cut stock To size 11¼ X 14*	*Squaring Shear*		
2	*Scribe shape on stock*		*Template 126-4 Scratch Awl*	
3	*Center punch hole locations*		*Template 126-4 Hammer, Center punch*	
4	*Shear corners and notches*		*Tin snips*	
5	*Bend hems*	*Box & pan brake*		
6	*Flatten hems*		*Hammer, Wood block*	
7	*Punch holes*		*Hand punch*	
8	*Bend sides 90°*	*Box & Pan Brake*		
9				
10				

Fig. 126-3. Parts List for Utility Box (Refer to Fig. 126-2)

Part No.	Part Name	Material Description	Size
1	Bottom	Tin plate	11¼" x 20"
2	Top	Tin plate	8¼" x 20"
3	End	Wood	½" x 3⅝" x 6"
4a	Handle	Acrylic plastic, clear	¼" x ¾" x 6"
4b	Handle	Acrylic plastic, opaque	¼" x ¾" x 6"
5	Hinge	Polyethylene	.060" x ½" x 1"
6	Stud	Common nail	10d
7	Hasp	Polyethylene	.060" x ½" x 2"
8	Screw	P. H. sheet metal	No. 4 — ½" long
9	Post	Pop rivet	⅛" dia. x ⅛"
10	Rivet	Pop rivet	⅛" dia. x ⅛"

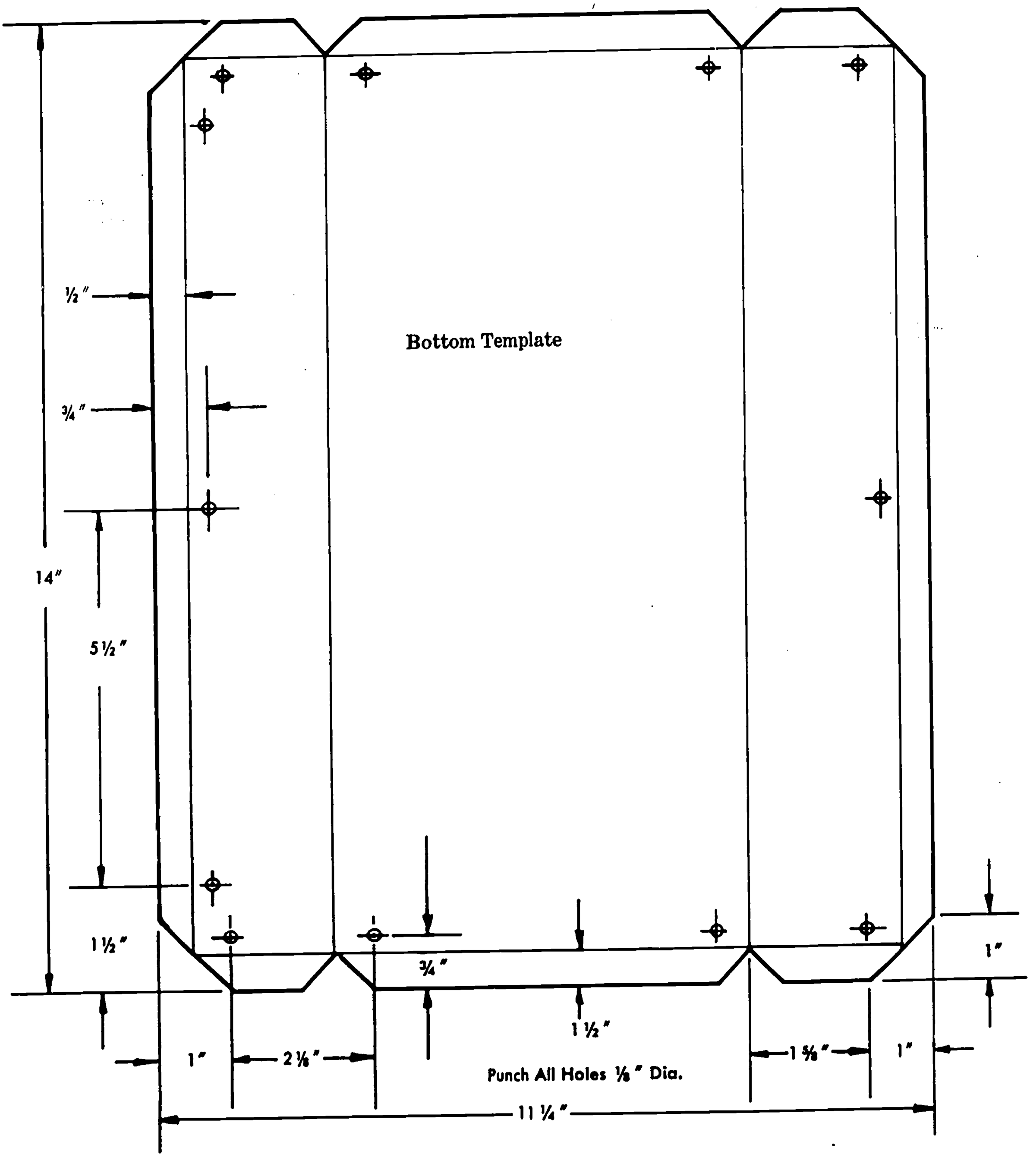


Fig. 126-4. Bottom Template 126-1 (Half Scale)
Material: 20 ga. galv. (Teacher make one.)

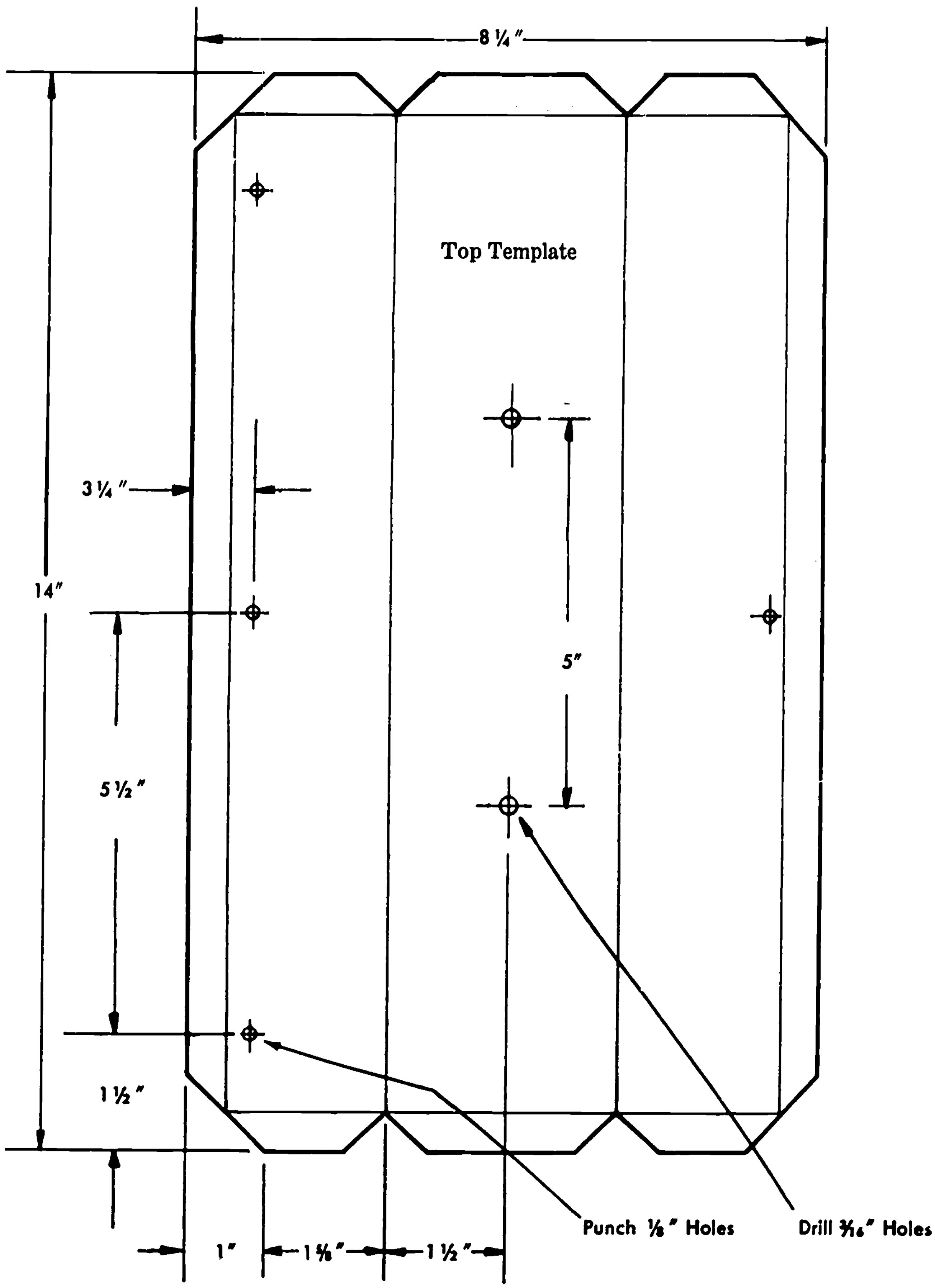


Fig. 126-5. Layout for Top Template 126-2 (Half Scale)
Material: 20 ga. galv. (Teacher make one.)

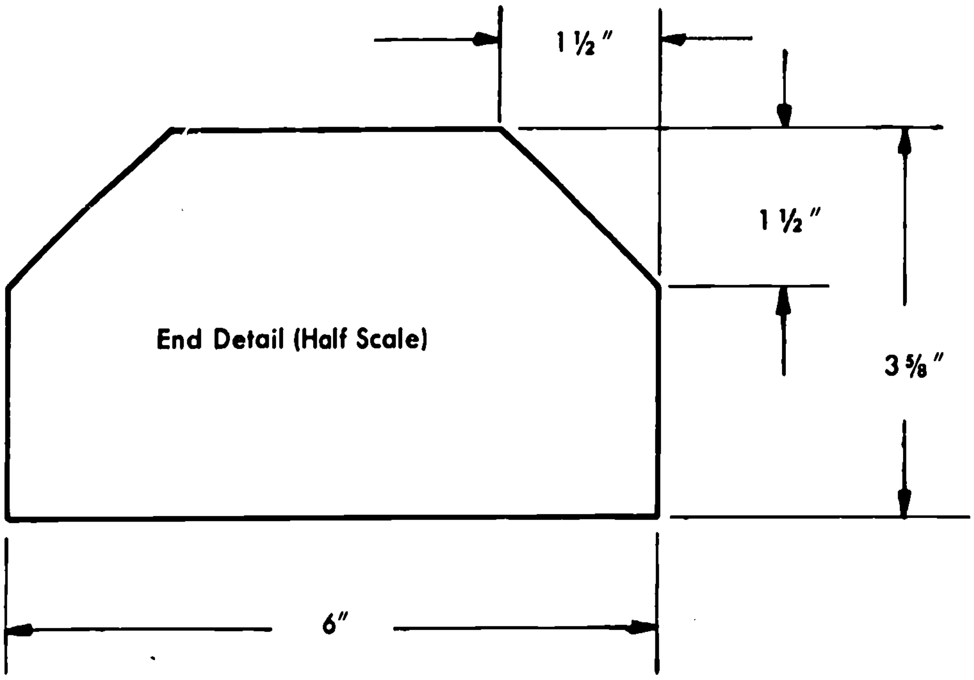


Fig. 126-6. End Detail

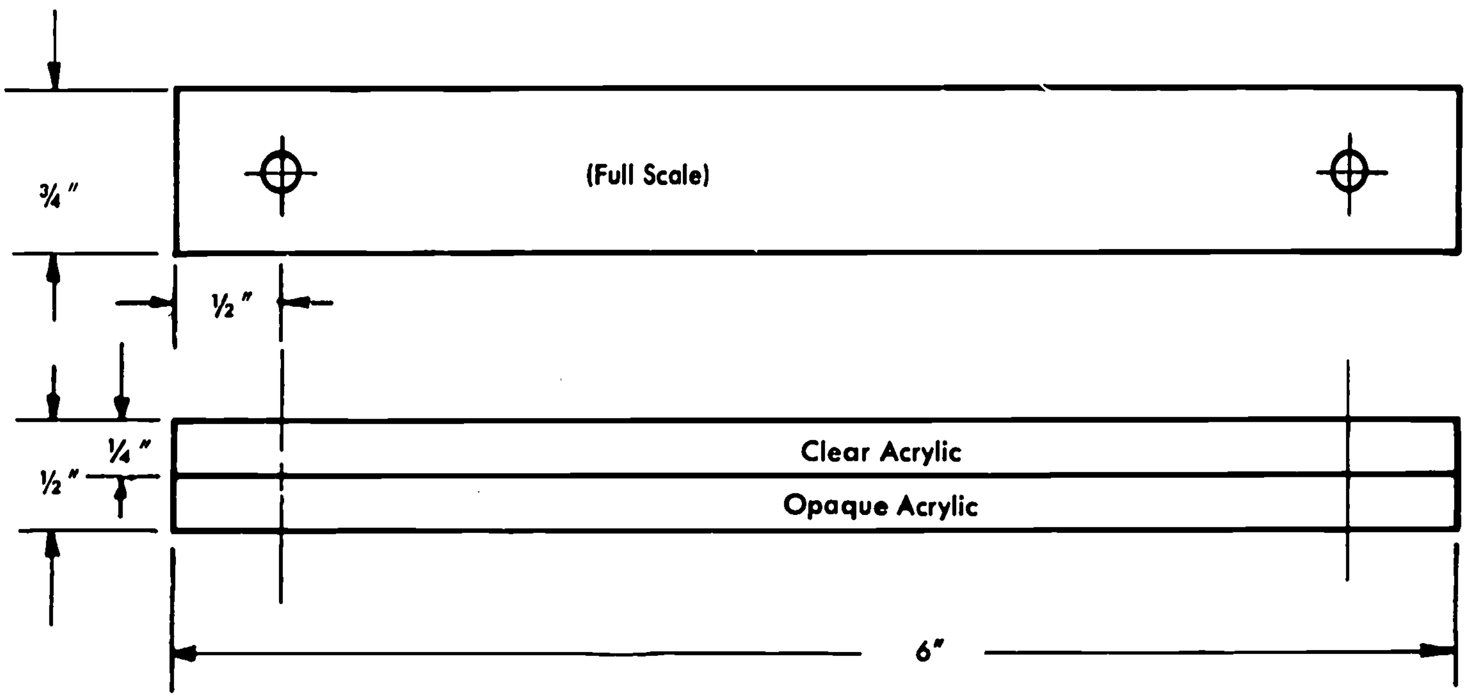
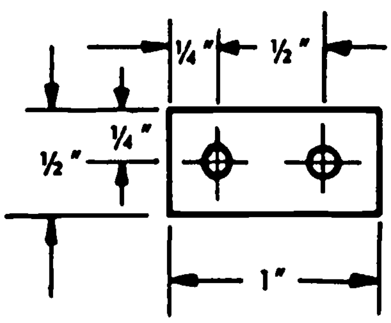


Fig. 126-7. Handle Detail



Full Scale

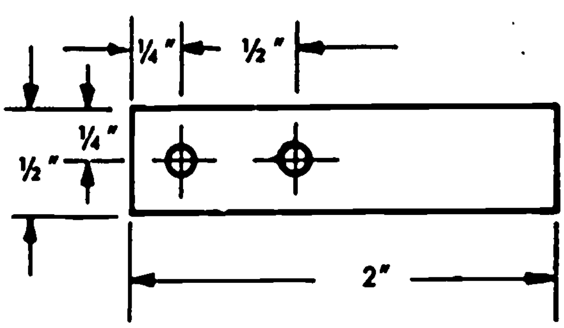


Fig. 126-8. Hinge Detail (Punch ⅛" Holes)

Fig. 126-9. Hasp Detail (Punch ⅛" Holes)

Note

1. Drawings for the templates, fixtures, and jigs are shown in Figs. 126-4, 5, 10, and 17. Figures 126-6, 7, 8, and 9, show details of the components and Figs. 126-13 and 14 will show you a picture of the completed box. Figures 126-15 and 16 show alternate designs for the box.
2. Students will complete Laboratory Manual Fig. 76A-10 upon completion of utility box. Answers appear in Teacher's Guide, Assignment 131-132.

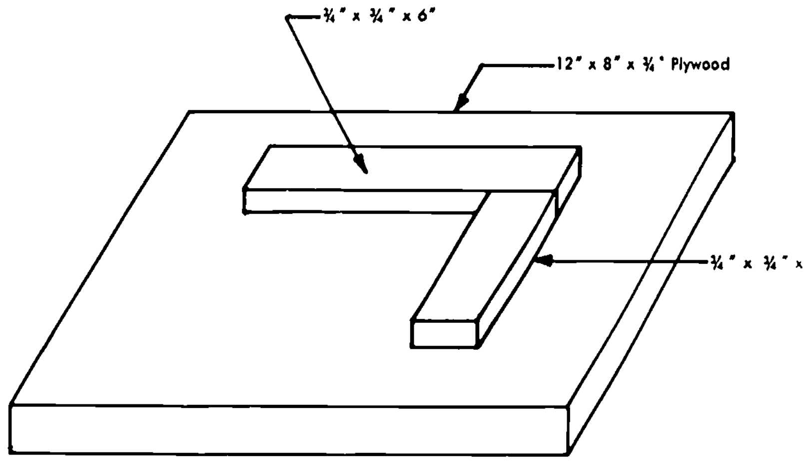


Fig. 126-10. Drilling Fixture for Handle 126-3 (Teacher make one.)

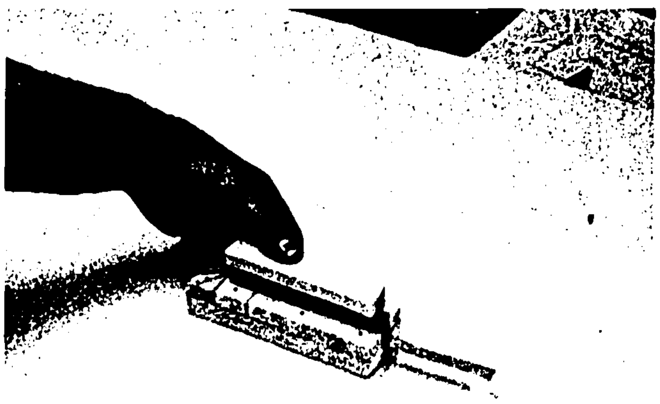


Fig.126-11. Hinge Marking Jig

Fig. 126-13. Completed Utility Box (Opened)

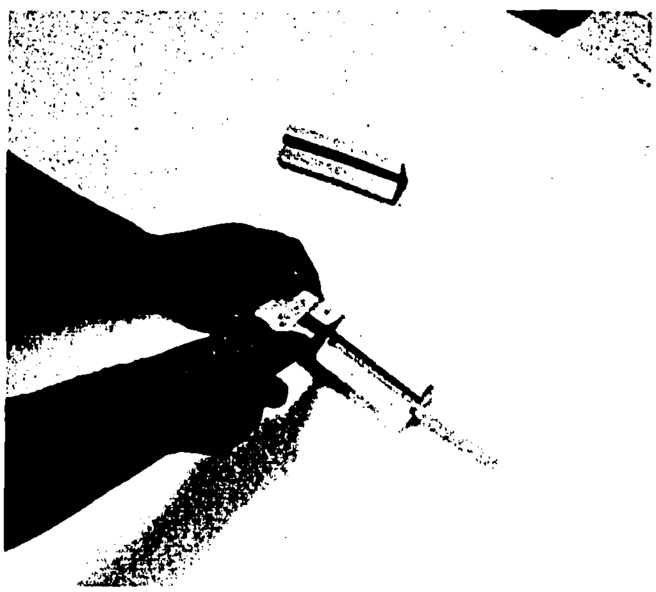


Fig.126-12. Hinge Cutting Jig

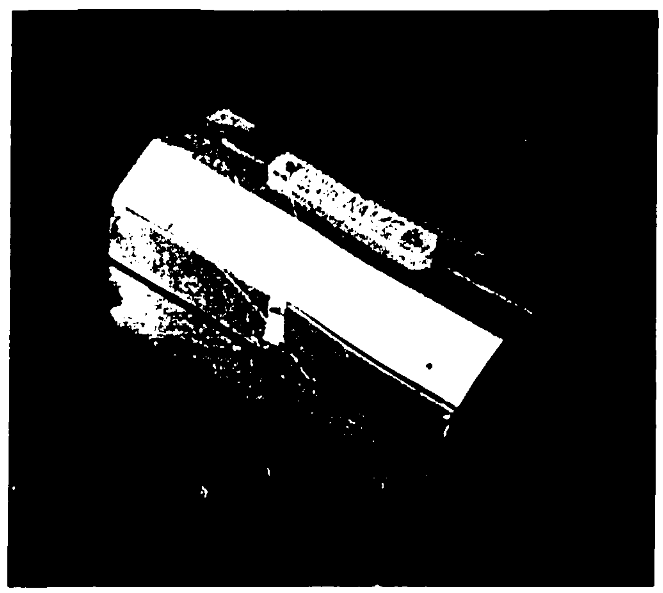


Fig. 126-14. Completed Utility Box (Closed)

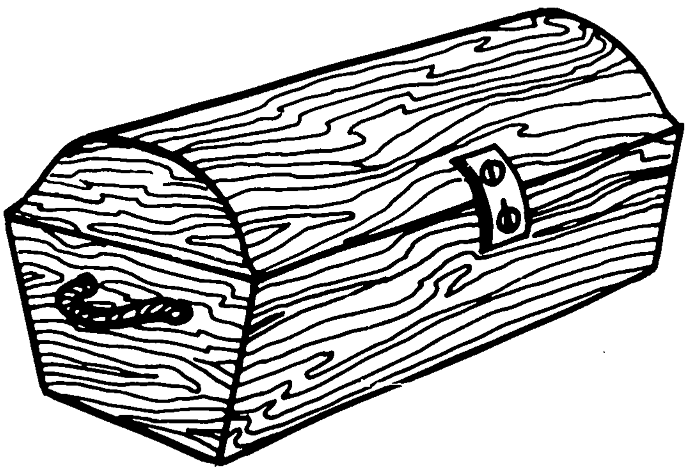


Fig. 126-15. Alternate Design

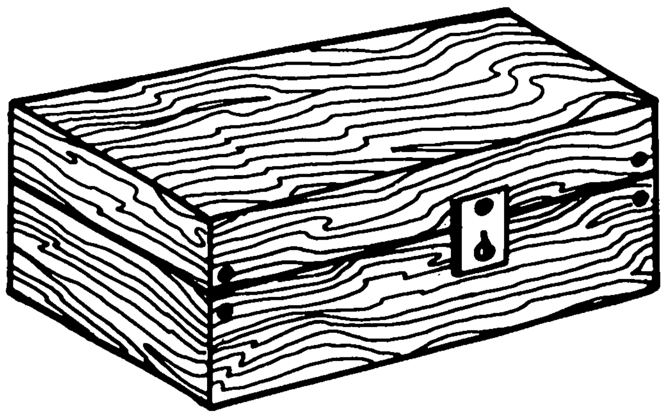


Fig. 126-16. Alternate Design

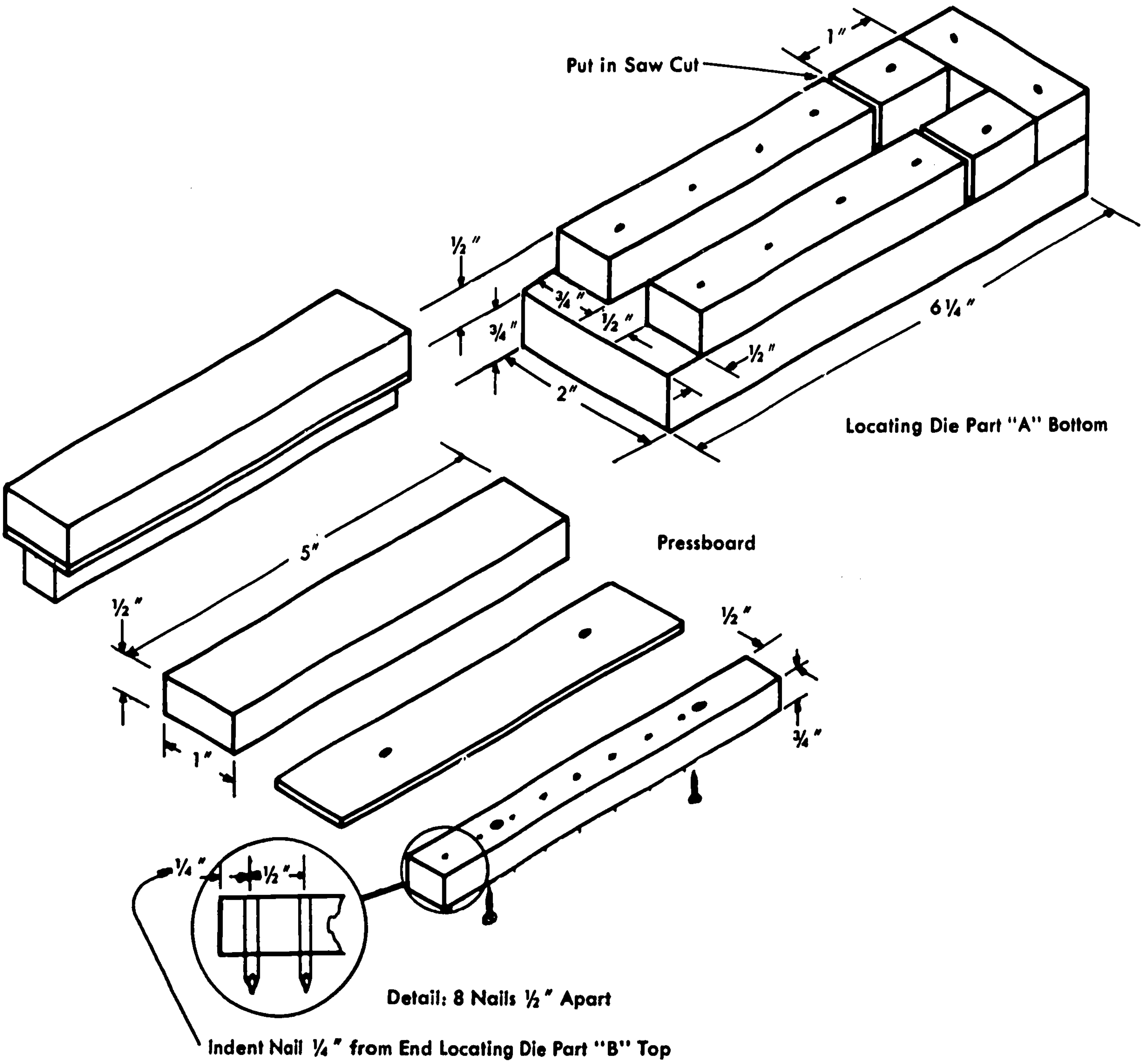


Fig. 126-17. Locating Die 126-4 A and B
(Teacher make one.)

ASSIGNMENT 127, 128
ACTIVITY 70A-G

Combining Subassemblies

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation on combining subassemblies:
   a. List two ways to change standard stock material.
   b. State why shearing is used to make subassembled parts.
   c. Name two chip removing processes used in making subassemblies.
   d. Name one "nontraditional" way of separating in subassemblies.
   e. Name two manufactured products that have many subassembled parts.

Laboratory Activity

2. Using the appropriate equipment and supplies, begin making subassemblies for the utility box.

Time Schedule

Assignment 127
5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Assignment 128
45 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Same as Assignment 126.

Overview (5)

1. Yesterday you learned how components are combined by mixing, coating, bonding, and mechanical fastening.
2. You also saw that there are different methods of assembly and that each worker has a specific job to do at a certain work station so that the product can be assembled in a short period of time.
3. Today you will learn various operations that are performed to make subassembled parts.
4. You will be asked to name processes and products used to make subassemblies.
5. You will begin the manufacture of components for the utility box. These will later be combined into subassemblies and then combined into the finished product.

Presentation (10)

1. You have learned that there are two ways of changing a standard-stock material: (a) forming, (b) separating.
2. Before any part can be assembled, standard stock must be separated by shearing, chip removing, or other processes.
3. *Shearing* cuts and gives shape to materials. It is less wasteful than chip removing in making subassembly parts. There are many and various shearing operations needed for one subassembled part to be manufactured into a final assembly.
4. *Chip removing* involves the removal of chips or small bits of material by using a cutting tool. Drilling and sawing are used in refining the subassembly and its parts.
5. Another way of separating involves a "nontraditional" approach to meet the need of an individual way of material separating. Thermal erosion (flame-cutting), chemical separating (etching), electrochemical (laser beam), induced fracture (glass cutting), are examples of "nontraditional" separating.
6. Remember that subassemblies in manufacturing refer to processes of putting several parts or components together to make one particular unit called a *subassembly*. An automobile or motorcycle has many different subassemblies such as the engine, transmission, body, chassis, interior, wiring, etc.

Discussion (5)

1. What are two ways to change the shape and size of any standard-stock material? (Forming, separating.)
2. Why is shearing used in making subassembled parts? (It is less wasteful than other processes because many sheared parts become components for subassembly, while other sheared products are final-assembled for consumers.)
3. List two processes of chip removing in the manufacture of subassemblies. (Drilling, sanding, etc.)

4. List one "nontraditional" way of material separating for a subassembled part. (Thermal erosion, chemical separating, induced fracture, etc.)
5. Name two manufactured products that have more than 50 subassembled parts. (Car, motorcycle, various motors.)

Laboratory Activity (25)

Today students will begin production of components for the utility box. The next four or five assignments will be a continuation of production and assembly.

1. The teacher will decide which system he will use for production and assembly.
2. Demonstrate safe and proper use of equipment where necessary.

System No. 1, Lot Assembly

a. Each group functions as a separate factory and manufactures a *lot* of five products.
b. The foreman of the group decides which worker in his group should be assigned to each task or tasks listed on the route sheet.
c. The teacher must direct each group to begin production on a specified component. As each group completes the required number of components, the teacher will then direct the groups to rotate through the various production centers.

System No. 2, Continuous Assembly

a. The teacher places each student at a production center or station and schedules the number of lines running each day. For example, shearing operations may be performed on all parts at one station, on different days.
b. Subassemblies absorb workers, while students with less time-consuming tasks complete their work each day.
c. As groups continue to complete their assigned production, final-assembly groups can be formed.
d. Production continues until the entire quantity for a particular item is completed.
e. The route sheet can also be used effectively to schedule the number of different operations and components in process at a given time. Several components have to be in progress at one time to prevent production delays.
f. The groups proceed to perform production operations, as assigned, until production is completed.
g. As individuals and groups complete components, they can be assigned subassembly and assembly work.

Homework

None

ASSIGNMENT 129, 130
ACTIVITY 70A-G

Combining Subassemblies

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation on forming:
   a. Name three major ways of forming.
   b. Name three examples of casting or molding.
   c. Name two processes of compressing or stretching.
   d. Name one type of conditioning technique.

Laboratory Activity

2. Given the necessary equipment and supplies, continue to make subassemblies for utility box using forming operations.

Time Schedule

Assignment 129
5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Assignment 130
45 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Same as Assignment 126.

Overview (5)

1. Yesterday you worked in the laboratory making components and subassemblies for the utility box.
2. Today you will learn how forming is used in making subassemblies.
3. I will ask you to identify some forming practices.
4. You will continue to make components using *forming* and *separating* practices for the utility box in today's laboratory activity.

Presentation (10)

1. Most finished manufactured products are shaped by a forming process. In order to obtain a desired result, there are three ways that industry may *form* any type of manufactured product during its assembly. They are: (a) casting or molding, (b) compressing or stretching, (c) conditioning material.
2. Forming by *casting* or *molding* is done by pouring a liquid or semiliquid into a cavity. When the liquid hardens or cures, the resulting material becomes solid and retains the shape of the cavity. Many products and components for both assemblies and subassemblies require a casting operation; for example, automotive engine block, power tools in our laboratory, glass, plastic, and rubber. All castings must have a *pattern* which is used to shape the mold cavity. The *pattern* has the identical shape of the desired casting.
3. Subassemblies can also be formed by *compressing* or *stretching*. These processes are classified in groups based on forces that change the shape of materials during certain forming operations. Examples of some of these forming operations are:
   a. *Rolling*, aluminum foil, spaghetti
   b. *Bending*, paper clips, wire coat hangers
   c. *Forging*, screwdriver blades
   d. *Compression molding*, pegboard, particle board
   e. *Drawing*, vacuum-forming plastic toys
4. *Conditioning* is a technique of forming in which material properties are changed by altering the internal structure of the material. The two major reasons for material conditioning are (1) to make the material easier to work during processing, or (2) to give the final product some particular quality or characteristic. The most common types of conditioning involve thermal conditioning, mechanical deformation, and chemical reaction.

Discussion (5)

1. Name the three major ways of forming. (Casting or molding, compressing or stretching, conditioning materials.)
2. Name three examples of casting or molding. (Automobile engine block, jello, cinder block. Answers will vary.)

3. Name two processes of compressing or stretching. (Bending, forging, rolling, drawing, compression molding.)
4. Name one type of conditioning technique. (Thermal conditioning, mechanical deformation, chemical reaction.)

Laboratory Activity (25)

Students will continue production of components and subassemblies for the utility box.

Homework

None

ASSIGNMENT 131, 132
ACTIVITY 70A-G

Combining Subassemblies

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a review presentation on combining subassemblies:
   a. Name four processes used to combine subassemblies.
   b. Name the two major types of assembly processes.
   c. Name two examples of products assembled in batches or lots.
   d. Name three examples of products assembled by continuous or line assembly.

Laboratory Activity

2. Given seven components and subassemblies produced in previous activities, combine these parts into a final-assembled utility box.
3. Complete Process Checklist, Fig. 70A-11.

Time Schedule

Assignment 131
- 5 Overview
- 5 Presentation
- 5 Discussion
- 30 Laboratory Activity

Assignment 132 (Optional)
- 45 Laboratory Activity

Equipment and Supplies for Laboratory Activity

See Assignment 126.

Overview (5)

1. Yesterday you worked in the laboratory making components for the utility box.
2. In today's presentation we will review how components are combined into subassemblies.
3. You will be asked to name how components are used in combining subassemblies.
4. In today's laboratory activity you will combine components and subassemblies into a final assembly of the utility box.

Presentation (5)

1. A component is a one-piece item or a single part that is used in making a product. Components that are joined together form subassemblies of a product. When subassemblies are joined, they result in a finished product.

2. All components are combined or put together by *mixing, coating, bonding,* and *mechanical fastening.*
3. These are the major processes for combining subassemblies or forming subassemblies into final products.
4. Industry has two major types of assembly processes.
   a. *Batch or lot assembly,* used for short production runs. Manufactured products that require mixing in batches or lots such as, photographic film, aspirin tablets, soft drinks, etc.
   b. *Continuous or line assembly,* when a uniform product is being manufactured continuously. Automobiles, motorcycles, and telephones are examples.
5. For any assembly process, men and machines must do a specific job at a certain place for the production to be made into a final assembly in a short amount of time.

Discussion (5)

1. Name the four processes used to combine subassemblies. (Mixing, coating, bonding, mechanical fastening.)
2. Name the two major types of assembly processes. (Batch or lot assembly, continuous or line assembly.)
3. Name two examples of products assembled in batches or lots. (Answers will vary; clothing, foods, photographic film.)
4. Name three examples of products assembled by continuous or line assembly methods. (Answers will vary; automobiles, motorcycles, telephones.)

Laboratory Activity (30)

1. Students will begin assembly of the components and subassemblies for the utility box.
2. Have students complete Process Checklist, Fig. 70A-10.

Homework

None

Note

1. Look ahead to Assignment 136. You will need to buy good bulbs and run 9 volts through them to make bad bulbs.
2. You will need to run down some of the batteries.
3. See the drawing of the continuity tester for help in assembling the kit. See Fig. 136-1.

Answers for Laboratory Manual

2. Bending (top and bottom)
4. Sawing (ends and handle)
   Sanding
   Filing
5. Shearing (top and bottom)
   Die cutting (hinge)
8. Cohesion (handle)
   Adhesion (studs to handle)
9. Riveting
10. Spraying (ends)

Com.'.ining Subassemblies

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Using the term "subassembly," describe five examples of subassemblies.

Laboratory Activity

2. Given a demonstration, subassemblies, and necessary tools, combine subassemblies to make two runs of five socket, wire, and plug assemblies.
3. Given the time and workmanship of two production runs, determine if production time was lowered without loss of quality.

Time Schedule

5 Overview
10 Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Demonstration

Equipment

1 pr. wire strippers
1 4" screwdriver
1 pr. diagonal cutters

Supplies

1 socket, 75w, 250-volt
1 pc. #18-2 lamp cord, 3' length
1 plug, snap-on type
1 rotary switch
2 wire nuts, solderless connectors
1 nipple, 2/hex nut, ½" x ⅜" dia.

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 pr. wire strippers
1 4" screwdriver
1 pr. diagonal cutters

Supplies (Group of 5)

5 socket, 75w, 250-volt
5 #18-2 lamp cords, any length
5 plugs, snap-on type
1 small box or paper bag
5 nipples w/hex nut, ½" x ⅜" dia.

Overview (5)

In recent units and activities, you have been studying and practicing various ways to combine components into subassemblies. Today you will apply some of these concepts to the practice of *combining subassemblies.*

1. Today I will demonstrate techniques for stripping electrical wires, attaching the wires to a socket, and installing a plug on the other end of the wire.
2. I will ask you to give examples of subassemblies.
3. In the laboratory you will produce socket, wire, and plug assemblies. The same assembly procedure will be used at a later time when the class manufactures lamps.

Demonstration (10)

Today I will combine three subassemblies to make an assembly. This particular type of assembly procedure will be needed when you wire desk lamps in a later activity.

1. Assemblies are combinations of two or more components. A light socket is an assembly composed of small parts. When it is attached to an electric lamp cord, it could become part of a trouble light. Therefore, the light socket is a *subassembly* of the trouble light.
2. The socket you use will be disassembled into three parts to permit attaching the wire. Disassemble the socket and loosen the screws.
3. Demonstrate splitting the wire about 1½" from one end.
4. Demonstrate stripping the insulation from each wire ¾" back.
5. Demonstrate twisting the end of the wires to make a tight fit around the screws in the socket and prevent fraying.
6. Demonstrate drawing the wires clockwise around the screws. Draw each wire tightly with the insulation close to the screw. Then tighten each screw against the wire.
7. Demonstrate cutting the surplus end of the wire with diagonal cutters.
8. Be sure that the bare wire is *completely*

covered by the paper insulation as you assemble the socket, and that the socket cover is securely locked in the cap. Let students examine the assembly closely.

9. Demonstrate tying a knot in the cord inside a lamp base to help keep the cord from pulling out of the lamp.
10. If screw-type plugs are used, an Underwriters' Knot is required. You will use a snap-on plug. Therefore you need not use the Underwriters' Knot.
11. If a switch is installed in the line, one wire *only* is cut to make the connection. You will not be required to install a switch today. If time permits, a switch may be connected during the demonstration.

Discussion (5)

1. Is the printed page in a book a subassembly? (Yes, the ink and paper are two combined components. They will be further combined into a book.)
2. Name five examples of subassemblies. (Answers will vary.)

Laboratory Activity (25)

Today each group will assemble five socket, cord, and plug assemblies. They will then perform the same operations to assemble five more socket, cord, and plug assemblies. They will then determine if the group reduced production time *without* lowering job quality on the second run due to job experience.

1. Use regular grouping arrangement.
2. Distribute to each group the necessary tools, five sockets, five lamp cords, and five snap-on type plugs.
3. Supplies are to be arranged in the middle of each table.
4. The foreman of each group should select a student for each task: (a) split one end of the cord and strip two wire ends ¾" back; (b) disassemble socket; (c) install wires under screws; (d) assemble socket. Foreman will install plug. The recorder should note the time for production of five assemblies.

Note

To avoid wear and tear to the sockets, do not have students snap covers in place.

5. When five complete assemblies have been placed on the table, the wire stripper is to cut each cord close to the socket. Another student may remove the plug at the other end of each cord, and place the parts in middle of the table for another round of assembly.
6. The students at each station should inspect work done at the previous station.
7. Continue production for the remainder of the laboratory activity.
8. Have students put equipment and supplies away and clean the work area. Supplies for each group can be stored in the paper bag or box.
9. If time permits, discuss results of production time and quality data.

Safety Precautions

Do not plug finished assembly into an outlet.

Homework

Reading 64, *Preparing for Distribution*

Note

1. The sockets and plugs will be used for Assignments 170-174, Making and Combining Components and Assemblies.
2. Contact a local stock exchange to secure a copy of description of corporations and their credit ratings by Dunn and Bradstreet to show the class for Assignment 141.

ASSIGNMENT 134, ACTIVITY 71
READING 64

Preparing for Distribution

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about preparing for distribution:
   a. Select a product from the kitchen with an attractive package, describe why this package is more attractive than others, and briefly describe the making of this package from raw material to finished product.
   b. Select a product you used today which went through the most complex distribution stage of manufacturing and describe the distribution steps of that product.

Discussion

2. Given packages for manufactured products, analyze and describe how the packages protect, label, and aid handling and storing of products.

Laboratory Activity

3. Given two typical packages for manufactured products and specific criteria, analyze how the packages protect, label, and aid handling and storing.

Time Schedule

5 Overview
20 Presentation-Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation - Discussion

The teacher is to use five of these suggested supplies to demonstrate the procedure students will follow:

Supplies

Provide the following packages or equivalents for demonstration:

1 frozen food bag *or* carton
1 glass jar, screw-off type lid
1 candy bar, wrapped
1 cut-away carton; e.g., Head and Shoulders® shampoo in a tube
1 box, powdered soap or detergent
1 silica gel or cereal package.

Equipment and Supplies for Laboratory Activity

Supplies (Class)

1 egg carton
1 cola case, 6-pack carton
1 plastic bag *or* mesh bag, fresh vegetable type
1 package, razor blades mounted on cardboard
2 boxes, toothpaste, deodorant, etc.
2 milk cartons, ½ gal.
1 box, cereal or other foodstuff
1 soft drink bottle and cap

Overview (5)

1. You have recently completed the making of the utility box. If you were shipping a quantity of these to a store for sale, you would need to design a package that would protect them.
2. The reading described ways of preparing products for distribution.
3. Today I will talk about some packages that I have collected for us in your work. We will analyze each of these packages: (a) how it protects the product; (b) how the package or label identifies the product; and (c) how packaging makes storing and handling of the product easier.
4. During the laboratory activity, you will analyze the design of a package and then discuss the advantages and disadvantages of the product in relationship to the package.

Presentation - Discussion (20)

1. Products must be protected from *rough handling, moisture, heat and cold, contamination,* and *loss.*
2. How are these products protected from *rough handling*? Show the samples and let students examine them.
   a. What packaging materials are used? (Rigid and flexible plastics, glass, wood, metals, cardboard.)
   b. Is more than one container used? Can you identify an *inside* and an *outside* container?

c. Is the product or inner container held or mounted in a special way? Note holes or pockets in an outside container that hold tubes, etc.
d. Are any packing materials used such as paper, cardboard spacers, sawdust, or foamed plastic?
e. Is the package strengthened by ribs, beads, grooves, bends, or folds?

3. How are these products protected from *moisture*?
   a. Is the package sealed? Look for folded or bonded closures.
   b. Are any plastic materials or metals used? Look for plastic bags, foil wrapping, etc.
   c. Are any wax, oil, or paint coatings used?
   d. Is silica gel used? Why? (It absorbs moisture inside the package.)

4. How is the product protected from *heat or cold*?
   a. Is a foamed plastic *insulation* used?
   b. Are metal *foils* used? Why? (A bright metal surface reflects heat.)
   c. Is the package made of several layers of material?

5. Is the product protected from *contamination*?
   a. Is the product *completely enclosed*?
   b. Is the product *sealed* against air, moisture, or dust? How is the package closed?

6. Is the product protected against *loss*?
   a. How is the package closed?
   b. Is it likely to come open?

7. Products are labeled to identify the manufacturer, the specific product, the quantity of items, the description, directions for use, and other special information about the product.

8. How is the *manufacturer* identified?
   a. Is there a *brand name* or *trademark*?
   b. Is the name of the *company* given?
   c. Is the country or *location of manufacture* given? (For example, Made in U.S.A., Mfg. in Cleveland, Ohio, etc.)

9. Is the *quantity* identified?
   a. Is a *number* of units or packages listed?
   b. Is the *weight* or *volume* of the contents given?

10. Is the product *described*?
    a. Is there a catalog number or serial number?
    b. Is anything stated about color, flavor, etc.?

11. Are *directions* given?
    a. For *opening*?
    b. For *use*?
    c. For safety or first aid? (For example, "Poison," "Caution," etc.)
    d. For special handling or storing? (For example, "This end up." "Fragile." "Use no hooks." "Keep from freezing.")

12. What other information is given?
    a. *Service* information, *guarantees*?
    b. Information in *languages* other than English?
    c. *Approval*, inspection, rating, or recommendation by various agencies? (For example, Underwriter's Laboratories (U. L.), U. S. Dept. of Agriculture, Good Housekeeping, etc.)

13. Packaging makes it possible to *store* and *handle* products efficiently.

14. How do packages aid in storing products?
    a. What *shape* is the package? (Round, square, rectangular.) What shapes *stack* together best?
    b. Is the container or package a *standard* size?
    c. Are special containers or spacers used for stacking? Are the containers designed for stacking?
    d. Does the package contain one unit or several units?
    e. Would the package support the weight of ten more packages of the same kind, stacked on top? 100 more? 1000 more?
    f. Is the package *compact*? That is, does it take up as little *space* as possible?
    g. Can the package be used to display the product?

15. How do packages aid in moving products?
    a. What kind of product must be moved? (Liquid, solid, gas.) How will the package be filled and emptied?
    b. How will the packages be moved? (By hand, fork lift, hooks, boxes, pallets, etc.)

c. Are handles or slots needed in order to grasp the package for movement?
d. How is the product removed from the package?
e. Will the package be *reused* or *discarded*?
f. Is the container necessary to the use of the product? (For example, salt, razor blades, etc.)

Laboratory Activity (20)

Today each group will analyze a package using the criteria specified in the Laboratory Manual, and then discuss the package in relationship to the product.

1. Students will work in their regular groups. Each group will have a package to analyze.
2. Groups will have 15 minutes to analyze the package and 5 minutes to discuss the advantages and disadvantages of the package for a specific product.
3. Move among the groups and assist students as necessary.
4. Have students return all packages at the end of the period.
5. Discuss solutions if time permits.

Homework

Reading 65, *Servicing Manufactured Products*

ASSIGNMENT 135, ACTIVITY 72A
READING 65

Servicing Manufactured Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on servicing manufactured products:
   a. Visit a neighborhood hardware store and identify five products that need servicing *before* they can be used and five products that need *no* servicing before they are used.
   b. Look at the advertisements in a magazine or newspaper and list five durable products and five nondurable products.

Discussion

2. Given nine service occupations, select whether the service is performed at home or in a shop.

Laboratory Activity

3. Using a crossword puzzle, complete the puzzle by identifying twenty durable and fifteen nondurable goods.
4. Using a word puzzle containing names of servicing occupations, locate and identify 25 out of 27 occupations.

Time Schedule

5 Overview
10 Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 Transparency 135, *Servicing Manufactured Products*

Overview (5)

1. Your reading explained that servicing includes such activities as installing equipment, keeping a machine in working order, making repairs, and altering a product to fit some special need.
2. Today we will discuss durable and nondurable goods, servicing personnel, and servicing equipment in homes and in shops.
3. You will work a crossword puzzle relating to durable and nondurable goods. You will also work a word puzzle using names of occupations related to servicing manufactured products.

Presentation (10)

1. Servicing of any manufactured product is classified as a *postprocessing* activity.
2. Both durable and nondurable goods may require service. Durable goods usually require service during their life. Nondurable goods may need servicing, but not to the same degree.
3. There are four kinds of servicing practices: *installing, maintaining, repairing,* and *altering.*
4. a. *Installing* means placing manufactured products into a permanent or semipermanent location.
   b. *Maintaining* means periodic service given a manufactured product to keep it as nearly new and as useful as possible.
   c. *Repairing* means replacing worn or defective parts.
   d. *Altering* means the remanufacture of a product, generally, for a purpose for which it was not originally intended.

Discussion (5)

1. What is the basic difference between durable and nondurable manufactured goods? (Durable goods usually last three years or more.)
2. What kinds of occupations involve servicing and servicemen? (Answers vary. It is suggested that students discuss service people in terms of whether the service and the service people come to the cutomer's home or the customer goes to the service people.)
3. Show Transparency 135, *Servicing Manufactured Products.* Ask students to identify if serviceman provides his service at the home or only at his shop, or both.

Servicing Manufactured Products

Service Person	His Service	At Customer's Home	At Service Shop
Dry Cleaner	Maintains, alters, repairs clothing		X
Radio-TV Repairman	Installs, repairs TV's and radios	X	X
Telephone Serviceman	Installs, repairs, alters phone apparatus	X	X
Rug Cleaner	Maintains, repairs rugs	X	X
Air Conditioner Serviceman	Repairs, maintains air conditioners	X	X
Small Appliance Repairman	Repairs appliances		X
Electrician	Repairs, installs, and alters electric circuitry	X	
Carpenter Remodeler	Repairs, alters construction work	X	
Service Station Attendant	Repairs, maintains autos, refuels tanks		X

Laboratory Activity (20)

1. Students are to complete both puzzles in the Laboratory Manual.
2. Puzzles can be assigned as homework if not completed in the allotted time.

Homework

None

Note

Look ahead to Assignments 139 and 140, Activities 79A and 79B.

1. Precut wood stock for rubber stamps.
2. Precut rubber blanks for the letters.
3. Obtain the use of the spirit duplicator for this activity.

Answers for Laboratory Manual

Crossword Puzzle

Durable Goods	Nondurable Goods
Across	**Across**
1 car	2 bulb
5 lock	3 newspaper
9 zinc	4 tire
11 aircraft	6 belt
12 light	7 yo-yo
13 rake	8 battery
14 drum	10 shoe
16 pans	15 posters
17 horn	
Down	**Down**
18 aluminum	21 pizza
19 bolt	22 soap
20 wrench	23 kite
24 felt	25 toast
26 can	29 pen
27 transistor	30 tape
28 file	15 paint
33 radio	
34 lumber	
35 telephone	
31 oil	

Servicing Manufactured Products

W	A	T	C	H	M	A	K	E	R	A	U	B	T	C	D	V	E	X	W
S	S	T	Z	R	P	Q	Y	N	R	E	F	I	N	I	S	H	E	R	F
E	B	O	D	Y	M	A	N	O	E	L	E	C	T	R	I	C	I	A	N
A	O	R	O	O	F	E	R	H	L	S	R	O	Q	N	N	P	E	R	G
M	O	P	A	I	N	T	E	R	B	L	I	M	P	D	S	A	M	E	I
S	K	G	U	A	V	W	I	U	B	K	F	T	T	R	T	P	O	P	H
T	B	R	I	C	K	M	A	S	O	N	A	I	I	A	A	E	J	A	K
R	I	R	V	S	A	Z	A	Y	C	L	G	C	N	P	L	R	L	I	N
E	N	T	W	U	Q	R	O	I	L	E	R	N	N	E	L	H	N	R	A
S	D	R	O	O	F	B	P	G	L	A	Z	I	E	R	E	A	D	M	M
S	E	L	F	U	R	R	I	E	R	P	M	O	R	Y	R	N	J	A	E
D	R	A	P	E	R	Y	G	C	T	J	K	L	H	H	F	G	E	N	C
P	L	U	M	B	E	R	T	A	I	L	O	R	I	A	D	E	W	E	I
C	I	N	A	H	C	E	M	S	U	T	A	I	V	N	W	R	E	X	V
A	B	C	O	P	T	I	C	I	A	N	A	Y	B	G	C	E	L	Y	R
D	R	Y	C	L	E	A	N	E	R	M	R	N	E	E	Q	R	E	P	E
D	F	G	H	E	C	U	S	T	O	M	I	Z	E	R	U	K	R	L	S

ASSIGNMENT 136, ACTIVITY 72B

Servicing Manufactured Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation on servicing:
   a. Name the term that identifies the process of locating a malfunction.
   b. Explain in one sentence how a malfunction is identified.
   c. Given the example of a flat tire on a motorbike, diagnose the procedure for repair.

Laboratory Activity

2. Given the malfunctioning system and the necessary equipment and supplies, diagnose and locate the malfunction.

Time Schedule

5 Overview
10 Presentation
10 Discussion
5 Demonstration
15 Activity

Equipment and Supplies for Presentation

Supplies

various service manuals
1 light bulb, burned out, any wattage
1 light bulb, good, any wattage
1 length wire, any gage, 2′ long

Equipment and Supplies for Laboratory Activity

Equipment (Group of 2)

1 continuity tester
1 pen light cell "AA"
1 circuit board. See directions in Assignment 133
2 D cell

Equipment (Class)

1 vacuum tube voltmeter *or* volt-ohmmeter

Supplies (Class)

15 approx. batteries, D cell, dead, as needed by students
15 approx. bulbs, burned out, as needed by students

Overview (5)

1. Yesterday you learned that there are four major servicing practices: installing, repairing, maintaining, altering.
2. You learned that there are many occupations involved in servicing.
3. Today we will talk more specifically about diagnosis and repair of manufactured products.
4. You will have an opportunity to diagnose a malfunctioning product.

Presentation (10)

1. Servicing practices extend the life and value of manufactured products. Post-processing services may be provided by a manufacturer, a retail store, a service company, or the customer.
2. Kinds of servicing include installing, maintaining, repairing, and altering.
3. *General* service procedures may be the same for a group of similar products: for example, washing machines or automobiles. However, *specific* service information also is needed for each make and model of the product.
4. It is impossible for a serviceman to remember every detail about each model of a certain product, therefore the need for service information.
5. The manufacturer of a product usually provides service information in the form of a service manual, owner's manual, or maintenance manual. Show samples of various types of service manuals.
6. Regardless of product or type of malfunction, when a malfunction does occur, a definite procedure is followed by the serviceman. This procedure might be in the form of a checklist in a service manual or on microfilm, or it may even be memorized by the serviceman.

Discussion (10)

1. How does a serviceman locate a malfunction? (Diagnosis.)

2. How does a serviceman diagnose a malfunction? (By following a set procedure, checking one thing at a time.)
3. What would you do if your bike or motorcycle had a flat tire? (Answers vary. Check for visible signs of a puncture; check stem for leak; remove wheel from vehicle; remove tube from tire, inflate, and submerge in water; locate leak.)
4. What would you look for if your car or motorcycle did not start? (Answers vary. Check ignition, fuel, battery, etc.)

Demonstration (5)

1. Demonstrate volt-ohmmeter to check voltage of batteries.
2. Demonstrate the use of the continuity tester, by touching the wire to the probe. Explain the circuit. Demonstrate continuity on a length of wire.
3. Demonstrate checking continuity on the burned-out light bulb, and on a good bulb.

Laboratory Activity (15)

1. Students will work in groups of two for this activity.
2. Teacher should have 15 to 20 burned-out bulbs and 15 to 20 dead batteries for programming malfunctions.
3. Teacher must program malfunctions for the first class. Each class will prepare the circuit board for the following class. See Laboratory Manual for a list of possible malfunctions.
4. Students should follow troubleshooting guide in Laboratory Manual. If one malfunction is located, continue as there may be more than one malfunction.
5. As students finish troubleshooting and repairing, they should program malfunctions for the next class.

Homework

If Optional Assignment 137 is used, have students review Readings 59-65. If Assignment 137 is not used, there is no homework.

Note

1. You will need to buy good bulbs and run 9 volts through them to make bad bulbs.
2. You will need to run down some of the batteries.
3. See the drawing of the continuity tester for help in assembling the kit. See Figs. 136-1 and 136-2.

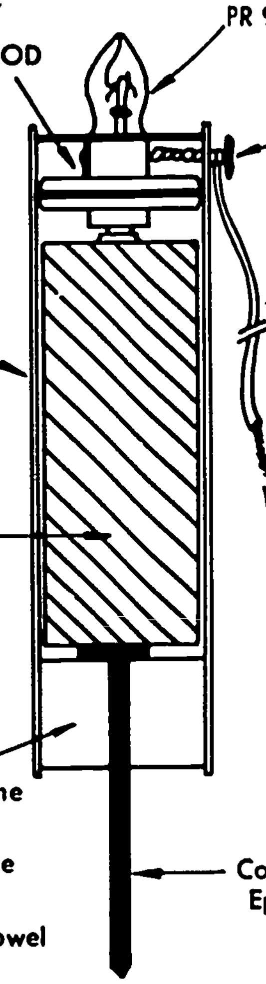


Fig. 136-1. Example of Internal Construction of a Continuity Tester

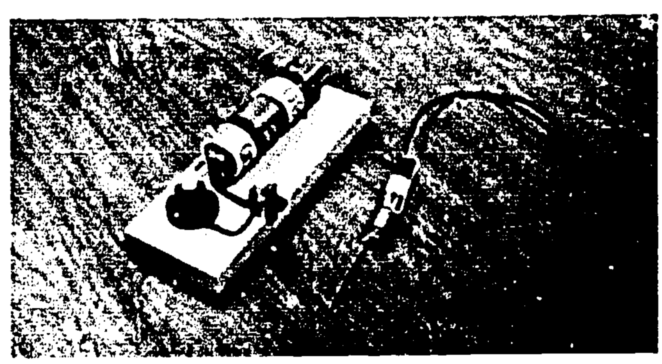


Fig. 136-2. The Official IACP Circuit Board and Continuity Tester Equipment Available from McKnight & McKnight Publishing Company, Bloomington, Illinois

Safety Precaution

Teacher should caution students to use continuity tester only on low voltage circuits with no power.

Answers for Laboratory Manual

1. located
2. troubleshooting

ASSIGNMENT 137 (OPTIONAL)

Review No. 8

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the summaries of Readings 59, 60, 62, 63, 64, and 65, ask and answer questions about (a) bonding, (b) coating, (c) mechanical fastening, (d) mixing, (e) combining subassemblies, (f) preparing for distribution, and (g) servicing manufactured products.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to do one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking and discussion.
3. Have each group of students get together and list two or three words or concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker who is knowledgeable about assembly lines to talk to the class. Schedule the speaker for the first class period and tape record his talk so that it can be played to your other classes.
5. Schedule a field trip to an assembly line.
6. Show a film related to one of the above readings.

Homework

None

ASSIGNMENT 138

Test No. 8

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 8, select the correct responses from a list of items related to concepts presented in Readings 59-65.

Time Schedule

45 Laboratory

Laboratory Activity (45)

1. Seat the students to best advantage for administering a test.
2. Distribute pencils, erasers, and eraser shields.
3. Place the test and answer sheet upside down on each student's desk.
4. At your command, have students turn over the tests and answer sheets.
5. Follow directions as given with the test.
6. Allow 35 minutes for completion; then collect test papers.
7. Review the test with students to provide feedback.

Homework

Reading 66, *Story of Printed Products*

Answers to Test No. 8

1. B	2. B	3. C	4. C	5. C	6. B	7. D	8. D	9. B
10. D	11. C	12. C	13. C	14. B	15. B	16. A	17. D	18. B
19. D	20. D	21. D	22. A	23. D	24. B	25. D	26. D	27. A
28. C	29. D	30. B	31. C	32. C	33. B	34. A	35. D	

ASSIGNMENT 139, ACTIVITY 73A READING 66

Story of Printed Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about the story of printed products:
   a. Name ten products other than newspapers, books, and magazines that carry printed information.
   b. Name the four basic kinds of printing processes and under each process list three products in the home that use each process.

Discussion

2. Given four transparencies on printed products:
   a. Name several products in the laboratory that have printing.
   b. Name five major groups of printed products and give examples of each.
   c. Name four major types of printing and a characteristic of each.
   d. Name the six principal steps to manufacture a printed product.

Laboratory Activity

3. Given the necessary equipment and supplies:
   a. Design, cut out, and assemble a rubber relief stamp.
   b. Print the pages of a note pad and assemble them.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen
1 rubber stamp pad, any color

Supplies

1 set Transparencies:
139-1. *Major Types of Printed Products*
139-2. *Four Basic Types of Printing Processes*
139-3. *Six Principal Steps of Producing a Printed Product*

Equipment and Supplies for Laboratory Activity

Problem 1

Equipment (Group of 5)

2 12″ rules
3 pr. scissors *or* X-acto® knives
2 ballpoint pens
1 set 1″ cardboard letters *or* have students make them

Supplies (Group of 5)

5 shts. $8\frac{1}{2}'' \times 11''$ plain paper
5 pcs. $\frac{1}{16}'' \times 1'' \times 2''$ inner tube *or* rubber gasket $\frac{1}{8}''$ thickness
1 btl. rubber cement, small, with applicator in cap
5 pcs. $\frac{1}{2}'' \times 1\frac{1}{2}'' \times 2\frac{1}{2}''$ wood

Problem 2

Equipment (Group of 5)

1 rubber stamp pad, large; various colors for different groups if possible
1 10″ parallel clamp, optional
1 padding brush

Supplies (Group of 5)

50 3″ x 5″ plain white cards *or* paper
1 old newspaper to cover table
6 pcs. 3″ x 5″ chipboard, for backs of note pads
1 pt. padding compound *or* white glue
2 pcs. 4″ x 6″ scrap wood

Overview (5)

1. You have read about the five major groups of printed products, the four types of printing processes, and the six principal steps in preparing a printed product.
2. I will tell you about some examples of printed products, types of printed products, basic printing processes, and the steps in preparing printed products.
3. You will be asked to list examples of the processes or products covered.
4. In the laboratory activity, you will prepare a special rubber stamp to print a personalized note pad. You will finish it by binding the pages together, in much the same way that paperback books are bound together.

Presentation (5)

The story of printed products involves many processes and products. Today we will look at some of those processes and related products.

1. Show Transparency 139-1, *Major Types of Printed Products.* Printed products can be put into five major groups. *Commercial* printing will be done in today's laboratory work. The varieties of printed products are endless. Can you name others in addition to these shown?
2. Show Transparency 139-2, *Four Basic Types of Printing Processes.* Printing processes can be divided into four basic types. Put your finger on an ink pad and then on paper. Hold it up to show a finger print. This is an example of *relief printing.*
3. Show Transparency 139-3, *Six Principal Steps of Producing a Printed Product.* Explain that "image" refers to the design to be printed. This is what they will see printed on the paper.

Discussion (5)

Guide the discussion to reinforce the concepts presented on the transparencies.

1. Name some examples of printed products. (Books, newspapers, magazines, catalogs, maps, money, calendars, etc.)
2. What *five major groups* of printed products have you studied? (Newspapers, periodicals, books, commercial printing, converted products.)
3. Can you name four basic types of printing processes? (Relief, planographic, intaglio, and screen stencil.) Which type will we use today? (Relief.)
4. Can you name, in order, the six principal steps in printing a product? (Create original composition, image preparation, image transfer, finishing, and distribution.)

Laboratory Activity (30)

The students will make a rubber stamp to print a note pad. Emphasize that this is one example of commercial relief printing.

1. Students will work in their usual groups of five. They will share certain equipment when necessary.
2. Each student will make his own rubber stamp and print his own note pad, using the color ink assigned to his group.
3. The students will bind their pads together as a group. White glue may be used instead of padding cement. Use a parallel clamp as a padding vise.
4. Assist students as necessary.

Safety Precaution

1. Students should wear shop aprons and safety glasses to keep ink from their clothes and eyes.

Homework

None

Answers for Laboratory Manual

1. Commercial product
2. Relief printing
3. Padding compound

Note

1. Save two or three copies of stock quotations, New York or American Exchange, from the local newspaper to be used in Assignment 144.

ASSIGNMENT 140, ACTIVITY 73B

Story of Printed Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given the supplies and equipment, print, fold, collate, bind, and trim a multi-page autograph booklet.

Time Schedule

5 Overview
10 Presentation
5 Demonstration
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1	spirit duplicating machine
5 pr.	scissors
5	12″ rules
1	15″ paper cutter
1	stapler, 5″ throat or larger

Supplies (Class)

6	spirit masters (5 purple, 1 red or green)
1 can	spirit duplicating fluid
1 jar	hand cleaner for removing spirit duplicating ink
5	rags
100 shts.	$8\frac{1}{2}$″ x 11″ duplicator paper

Overview (5)

1. Yesterday, you studied about printing processes and did some relief printing.
2. Today, I will show you how to prepare a spirit duplicating master for printing.
3. I will show you how to carry out the steps in manufacturing a book.
4. In the laboratory activity, you will produce an autograph book.

Presentation (10)

A book is a manufactured product that has been through many processes.

1. The *contents* (facts and ideas) are first chosen and recorded as words and pictures. For a textbook this work is done chiefly by authors, illustrators, and editors.
2. For each page of the book a *printing plate* or *master* of some kind must be prepared.
   a. For small, office-type duplicators each *master* prints on $8\frac{1}{2}$″ x 11″ sheets of paper. Mimeograph machines, multigraph machines, and spirit-duplicating machines print pages this size.
   b. For larger presses, each printing plate may represent four or eight book pages.
   c. Printing plates or masters are of many kinds. Today you will prepare a very simple kind of master. It is a sheet of paper with a heavy load of wax and dye on the areas to be

printed. This kind of master is used in a process called *spirit duplicating.*

3. After the printing plates or masters are prepared, every page of a book must be reproduced. Hundreds or thousands of copies are *printed* from each plate.
   a. The paper that receives the printed *image* may be in sheet form. A press that prints individual sheets is called a *sheet press* or a *sheet-fed press.*
   b. The paper may be fed into the press in a very long, continuous roll. The presses that print city newspapers are of this kind. They are called *web presses* or *web-fed presses.*
   c. Some of the books used in schools are printed on sheet presses and others on web presses.
   d. A press that prints on a roll or web of paper must have a cutting and stacking device, to cut the paper into sheets after it is printed on both sides.
4. If one printed sheet represents four or eight book-pages, it must be *folded.*
   a. Each spirit master that you prepare today will represent four pages of a small book.
   b. After you fold the sheets, you will see why some of the *images* were upside-down on the paper master.
   c. In the printing industry each large sheet, carrying the images of four or eight book-pages on each side, is called a *signature.*
5. All the sheets for a single book must be put together in order. This is called *collating.*
6. After collating, the book pages are *bound* together.
   a. Some binding processes involve sewing or stitching.
   b. Some make use of glue.
   c. Today you will bind your autograph booklets with wire staples.
   d. Spirals of wire and spines or "backbones" of plastic are other mechanical devices for binding.
7. When books are produced from folded four-page or eight-page sheets, at least one edge must be *trimmed.*
   a. In some processing procedures, pages are trimmed *before* binding.
   b. Today you will trim pages after binding.

Demonstration (5)

1. Before class prepare one spirit duplicating master as follows:
   a. If convenient, obtain a red or green master. You will be preparing the cover pages for the autograph book, and a contrasting color will make them more attractive.
   b. Select a cover design. One of the designs developed for screen printing pennants may be used.
   c. With the cushion sheet in place, lightly rule two lines to divide the master into fourths. See Fig. 140-1.
   d. Remove the cushion sheet. Position the front-cover design and transfer it to the paper.

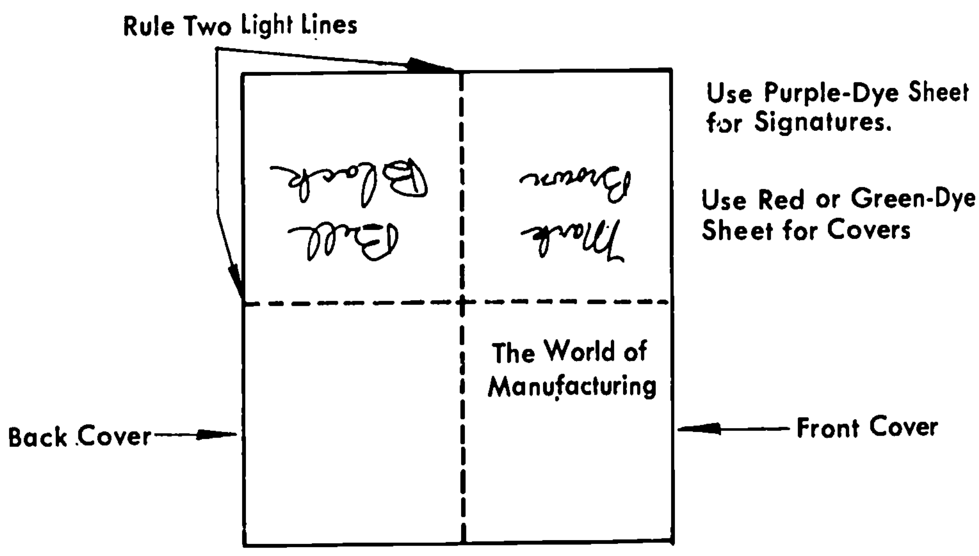


Fig. 140-1. Book Cover Master

e. Enter the class section number and publication date on the section that represents the back cover.

f. Tear off the red- or green-dye sheet. It may be used again. Replace it with a purple-dye sheet. Use paper clips or masking tape to hold this dye sheet in place.

2. Have two students sign the paper master, as in Fig. 140-1.
3. Remove the purple-dye sheet. Show students the reverse printing and design on the back of the paper master.
4. Demonstrate briefly the operation of the duplicating machine.
   a. Indicate that you will give special help to students who will use this machine later.
   b. Explain that spirit duplicating *fluid* dissolves the dye, a little at a time, to form a kind of printing ink.
5. Demonstrate folding, collating, stapling, and trimming. Follow the Laboratory Manual procedures.
6. Emphasize caution in handling spirit masters.
   a. Always throw away the dye or "carbon" sheet *immediately*, when you finish preparing a master. The purple dye is very hard to remove from some materials, and it spreads over large areas.
   b. Use the special hand cleaner if you get dye on your fingers. Do not touch your face with stained fingers.
   c. If you save a master after printing, cover the back with a sheet of paper.

Laboratory Activity (25)

1. The students are to work in their regular groups of five. When they prepare paper masters, two will sign their names on the same "page" or section of a master.
2. Check students as they make the masters, to see that their names are placed properly and that the thin cushion sheet has been removed. Provide help as needed.
3. When the masters are ready, assign each group one of the following jobs: printing, folding, assembling, binding, or trimming. Arrange the tasks sequentially.
4. Give as much help as necessary to the group that performs the printing operation.
5. Carefully watch the time as the students manufacture their booklets. Allow time for returning equipment and supplies, and cleaning the laboratory.
6. There are questions in the Laboratory Manual, at the end of the activity.

Homework

Reading 67, *The Manufacturing Corporation*

Answers for Laboratory Manual

1. Signature
2. a. Printing
   b. Folding
   c. Assembling
   d. Binding
   e. Trimming

ASSIGNMENT 141, ACTIVITY 74
READING 67

The Manufacturing Corporation

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about the manufacturing corporation:
   a. Look in the yellow pages of the local phone book and find five corporations and explain how you know they are corporations.
   b. To sell a new service, describe how to go about finding the names of the five largest corporations.

Discussion

2. Given a presentation and questions, state at least *three* advantages and at least *two* disadvantages of a corporation.

Laboratory Activity

3. Given the appropriate Laboratory Manual figures and a set of slides:
   a. Identify some advantages and disadvantages of corporations.
   b. Name three corporations and identify their trademarks.

Time Schedule

5 Overview
15 Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen
1 slide projector

Supplies

1 Transparency 141, *Characteristics of a Corporation*
1 Filmstrip 141, *Corporations and Their Trademarks*

Overview (5)

1. Yesterday you learned about the Story of Printed Products. Today you will use what was learned to make a Service Manual for the lamp you will be producing.
2. The reading focused on the history of modern manufacturing corporations. The reading explained that laws regulate and restrict the way corporations operate. It explained some of the terms related to a corporation.
3. Today I will show a transparency illustrating some of the major characteristics of a corporation, and explain some of their advantages and disadvantages. You will see a short slide presentation featuring various corporation buildings and their trademarks.
4. You will be asked to identify three advantages and two disadvantages of a corporation.
5. In your laboratory activity you will identify advantages and disadvantages of corporations. You will also be asked to identify the trademark of some corporations.

Presentation (15)

The manufacturing corporation is one way of *organizing* a company.

1. It receives its *charter* from the *state* in which the corporation is formed. The charter, called Articles of Incorporation, is a legal paper giving the corporation permission to exist and do business.
2. A corporation has the right to issue shares of *stock*. The two types of stock issued are *common* and *preferred*.
3. Anyone dealing with a corporation can check a reference book called *Dun and Bradstreet*. Show class the publication if you have it. This book lists all legal corporations and gives information about how reliable and financially strong each one is.
4. Show Transparency 141, *Characteristics of a Corporation*. Here are some of the important facts about corporations. Most of these things would *not* be true of a partnership or a proprietorship; they are special *characteristics* of a corporation.
5. A corporation has many *advantages* or benefits.
   a. It is a legal *entity* that can be brought to court in a legal suit.
   b. The officers of the corporation are *not*

liable personally for the actions of the corporation, but the *corporation* must obey the law and pay its debts.

c. A *charter* granted to a corporation gives it certain rights and privileges.
d. The issuing of *stock* permits control of the corporation to be spread out, because each share of stock entitles the stockholder to one vote per share.
e. *Efficient management* is encouraged in a corporation, because even the president and the board of directors are responsible for their action. They can be fired or dismissed for wrong decisions.
f. A corporation has *longevity*. This word means "long life." A corporation exists separate from its organizers, officers, and stockholders. It continues to exist when they are replaced or die.

6. A corporation has some *disadvantages*.
   a. There is a great deal of *expense* and *inconvenience* in forming a corporation.
   b. Very small corporations often have a hard time getting *loans* or financial backing because bankers know that they cannot turn to corporate officers or stockholders for repayment of the loan in case the corporation is not successful.
   c. Corporations often pay *high taxes* at both the state and local levels. In addition, corporate profits are subject to *double* taxation. The corporation pays when the profit is earned. Then the stockholders again pay taxes on this profit when they receive and declare it as income.
   d. The law may require periodic *reports*, which may distract from the task of making and selling the firm's products.
7. Let's look at a dozen slides. As you look at them, try to keep in mind each one's *name* and its *trademark*. Most should be familiar to you.

Script for Filmstrip No. 141 — 16 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Corporations and Their Trademarks*
5. Fisher Body of General Motors Corporation.
6. Continental Can Company.
7. 3M - Minnesota, Mining, and Manufacturing Co., makers of Scotch Tape, etc.
8. Worthington Steel Co.
9. AVCO Broadcasting Co. - Audio-Visual Co. Note NBC's trademark.
10. International Paper Company.
11. International Harvester Company.
12. Mooney and Moses Insulation.
13. B. F. Goodrich Company.
14. General Electric Corporation.
15. In-Flight Devices Corporation.
16. Illinois Central Piggyback - trucks for the railroad. Note the "IC" on the front of the trailer behind the cab as well as within the "pig."

Note

It is suggested you take additional slides of local corporations. Include a sign of the corporation *name* and its *trademark* with their colors if possible.

Discussion (5)

1. What are some *advantages* of corporations? Students should recall three.
   a. They are legally responsible in a court of law, but individual officers cannot be held individually responsible.
   b. They are granted certain rights by means of a charter.
   c. Control is maintained by stockholder voting; this tends toward democratic management.
   d. They generally have efficient and economical operation.
   e. Corporations have longevity.
   f. It is easier to raise financial capital through selling corporation stock than by other means.
   g. Large-scale production is easier for a firm with a large amount of capital.
   h. A corporation is usually more flexible than a partnership or proprietorship.
   i. Expansion is easier.
   j. It can attract highly capable personnel.

k. It can develop an efficient management program.
l. One officer cannot make contracts that are binding on the corporation, as one partner can do in a partnership.

2. What are some *disadvantages*? Students should recall two.
   a. They tend to reduce competition.
   b. Their spending power, collectively, is great, and some corporations can force their will on persons and/or other companies — even on countries.
   c. Stockholders have limited liability, a disadvantage from the standpoint of persons outside the corporation.
   d. Corporations generally have to pay more tax, because the corporation is taxed on gross profits made and stockholders are taxed on dividends declared.
   e. They must operate under strict rules and regulations.
   f. Organizations may be expensive, complicated, and inconvenient.
   g. They can cause price-fixing which, especially from the consumer's point of view, is a disadvantage.
   h. Limited liability can be a disadvantage when lending institutions are reluctant to loan money on an account.

Laboratory Activity (20)

Today the students will discuss and list (a) advantages and disadvantages of a corporation and (b) three corporation names and their trademarks.

1. The students will complete Fig. 74-1, checking advantages and disadvantages of corporations.
2. In Fig. 74-2 the students will list three corporations they recall from the slides with their respective trademarks. Inform the students they will select a corporation name and trademark for their lamp corporation in the next activity.
3. If time permits, have students complete the questions in the Laboratory Manual. Go over this and correct it with the students.

Homework

Reading 68, *Forming a Corporation*

Note

The teacher should collect examples of job application forms for the students to examine in Assignment 145, Relating People to the Corporation.

Answers for Laboratory Manual

1. Entity
2. Charter
3. Joint stock
4. State
5. Customers
6. F
7. T
8. T

Answers for Fig. 74-1:

1. Advantages: Nos. 5, 6, 9, 10, 11, 12, 13, 14, 15
2. Disadvantages: Nos. 7, 8

ASSIGNMENT 142, ACTIVITY 75A
READING 68

Forming a Corporation

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about forming a corporation:
   a. Identify where in the community one would go to find the rules and regulations that control corporations in your state.
   b. List three major manufacturing corporations that have their legal residence in your state and tell how this information can be found.

Discussion

2. Using the filmstrip presentation as a reference:
   a. Name three basic steps in forming a corporation.
   b. Name three probable advantages of a corporation in manufacturing of products.

Laboratory Activity

3. Given requirements for forming a corporation, select a corporate name.

Time Schedule

5 Overview
15 Presentation
10 Discussion
15 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 slide projector w/screen

Supplies

1 Filmstrip No. 142, *Overview of Manufacturing Corporation*

Equipment and Supplies for Laboratory Activity

Supplies (Group of 5)

5 shts. $8\frac{1}{2}'' \times 11''$ paper

Overview (5)

1. Yesterday you saw a filmstrip that illustrated corporations and their trademarks, and learned about the advantages and disadvantages of forming a corporation.
2. From your reading you have learned that a corporation has certain advantages and disadvantages.
   a. The corporation is a separate entity. It can sign contracts, borrow money, and sue or be sued in a court of law.
   b. Each stockholder owns a "piece" or fraction of the corporation. Stockholders control the corporation indirectly through their voting power. Each share of stock entitles its owner to one vote.
   c. The corporation is run by its principal officers. The *president* is responsible to the *board of directors*. Managers such as *vice presidents* and *superintendents* are responsible to the *president*.
   d. Both management and production strive for efficiency in a corporate structure, because both can be held responsible.
   e. A partnership or a proprietorship does not excuse the principal officers from legal obligations.
   f. Corporations can reduce competition because of their size and spending power.
3. I will show an overview of our activities for the next three weeks.
4. You will be asked to discuss some of the activities viewed in the filmstrip presentation.
5. We will then select a corporate name.

Presentation (15)

Script for Filmstrip No. 142 — 26 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois

4. *The Manufacturing Corporation*
   These next few slides will show the highlights of the events which will take place during the rest of our school year.
5. There is a regular procedure for forming a corporation. We will follow these steps in detail later on.
6. The *Articles of Incorporation* form must be completed and submitted to the Secretary of State. We will elect an *agent* and three people to serve as *incorporators.* These people will complete the necessary forms.
7. Any business requires capital (money) to operate. Large companies obtain money by selling stock. Here is a stockbroker's office where stock is bought and sold. Notice the *ticker tape* and the *big board.*
8. After the necessary forms are filed, and money is obtained, the stockholders will select a *Board of Directors.* The board of directors will select a chairman and also a president. Each of you will be stockholders in our company. Here the president discusses the need for workers to manufacture high intensity lamps.
9. A *Consumer Survey* is then conducted to determine the needs of the public and to make possible a *Sales Forecast.*
10. After we know which design is most likely to sell, we will make working drawings.
11. We will make a prototype as one of the first steps in engineering the product. Here you see the many parts which must be manufactured to make a complete lamp.
12. In big business you must know how many products you need to produce before a profit is made. We study a *break-even chart* to learn how this is done.
13. Here you see a *Production Flowchart* which allows you to see at a glance the stations where parts are produced and the flow of materials during production.
14. We will make jigs and fixtures so the parts we make will be accurate and interchangeable.
15. After all the details are worked out, we will produce parts at various stations. The quality control man will inspect parts at critical steps along the way.
16. This student is using a bending fixture to make uniform bends on the lamp stem.
17. After all the parts are produced, we will combine components and subassemblies to make the final products.
18. When you purchase a new product you expect it to be of high quality. We want to insure that our lamps will be of high quality; therefore each lamp will be inspected and approved before distribution.
19. This gives you an idea of what you, as a class, can accomplish by working together in a managed-personnel-production system.
20. Most good products include a *Service Manual.* Since we are making a quality product, we will make our own service manual. Here you see the covers being made.
21. We will use the ditto machine to make the signatures. The completed eight-page manual will be helpful for maintaining your lamp.
22. Here the pages and cover are collated, trimmed, and stapled.
23. A package will be designed and produced to identify and protect our products.
24. Here some students display some packaged products which have been manufactured and are ready for distribution. Notice the corporation name and trademark.
25. "Going Out of Business." Companies occasionally go out of business (or *liquidate*) for many reasons. After our products are produced we will terminate our corporation. You will learn about the various steps involved.
26. The books must be balanced (and a closing statement sent to each stockholder). If the company has a surplus of money, each stockholder receives an equal amount per share by returning his stock certificates to the vice president of finance.

Discussion (10)

The filmstrip presentation showed some of the activities related to a corporation.

1. Name three basic steps in forming a corporation.
   a. Incorporators appoint an agent to file Articles of Incorporation.
   b. The incorporators and the agent complete the forms necessary for incorporation.

c. Money for starting the corporation is obtained from sale of stock.

2. Name three probable advantages of a corporation in manufacturing our product.
   a. Large sums of money can be obtained by sale of stock.
   b. We risk only the money we have invested in the corporation.
   c. We can realize the advantages of large-scale production.

Laboratory Activity (15)

Students will select a name for the corporation.

1. Each student will write three different names that would be appropriate for our corporation.
2. Each group will select the one name they think is best.
3. The teacher will write on the chalkboard the name selected from each group.
4. Conduct a class vote by a show of hands to select the one best name.

Homework

None

Note

Obtain one or two samples of stock certificates for presentation in Assignment 144.

Forming a Corporation

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation on incorporating a company, name three basic steps in applying for a charter.

Laboratory Activity

2. Given requirements for forming a corporation:
   a. Elect three students to the board of incorporators.
   b. Name the corporation.
   c. Select an agent.
   d. Fill out the forms to obtain a charter.
   e. Design a trademark.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen
1 transparency marker, other than black

Supplies

1 set Transparencies:
143-1. *Original Appointment of Agent*
143-2. *Articles of Incorporation*
1 IACP Manufacturing Corporation Plant Layout Chart No. 143
1 roll tape
5 stickers to simulate a state seal to be affixed to completed documents

Equipment and Supplies for Laboratory Activity

Supplies (Group of 5)

5 shts. 8½" x 11" paper

Overview (5)

1. Yesterday you saw an overview of the activities relating to our corporation and selected a name for the corporation.
2. Today we will study in detail the steps in forming a corporation and proceed to incorporate to manufacture desk lamps.
3. I will tell you the procedures for starting a corporation.
4. You will be asked to name the steps in applying for a charter.
5. As a laboratory activity, you will form a corporation and design a trademark for the corporation.

Presentation (5)

There is a regular procedure for starting a corporation.

1. The proper forms must be secured from an official of the state government.
2. The application for a corporation charter must come from three or more responsible people called the *incorporators*.
3. An agent selected by the incorporators files the application usually with the Secretary of State.
4. The general purpose of the corporation must be stated in the application. For example, a lamp will usually be produced by a company that specializes in lighting fixtures.
5. The main or *principal address* of the corporation must be chosen, and stated in the application.
6. At an organizational meeting, the stockholders elect the board of directors, issue stock certificates and collect the money, and adopt the bylaws of the corporation.
7. The bylaws for the corporation should state the duties of the corporation officers, time of directors' and stockholders' meetings, and payment of dividends.

Discussion (5)

As a class, you are preparing to incorporate. You will need to know the necessary steps.

1. What is the first step you will take to incorporate? (Three or more responsible people, the incorporators, meet together.)
2. What will the incorporators need to do? (They decide on a general Statement of Purpose; choose the state in which they will incorporate, and a principal address; choose a name for the corporation; and appoint an agent.)
3. How do they get a charter? (They obtain application forms from the state, fill in all the needed information, and return the completed forms.)
4. What are some of the other steps? (Bylaws must be written, and later adopted at a stockholders' meeting. Stock must be issued.)

Laboratory Activity (30)

Today the students will take steps to incorporate a company for production of a desk lamp.

1. Have the students select (by vote) three class members to serve as *incorporators*. Suggested voting procedure: Nominate five or six students; vote using the head-down, hand-raised procedure, with the teacher counting.
2. The three board members choose their chairman.
3. The teacher should act as Governor of the state and appoint a Secretary of State.
4. Students must decide on a principal address for the corporation. Your school could be a suggested address.
5. The board chairman will contact the Secretary of State to obtain the necessary incorporating forms.
6. Each student is to fill in Fig. 75-1, Original Appointment of Agent, in the Laboratory Manual.
   a. Use Transparency 143-1, *Original Appointment of Agent*, to assist students. Note: Do not expect the students to read the printed material. Use Transparency 143-1 only as a guide.
   b. The names of the board members and agent can be written on the transparency with grease pencil.
   c. One copy of the document should be signed by the designated individual (the Secretary of State) and posted on a bulletin board. Note: The Secretary of State will affix a seal to the document before it is posted.
7. Each student is to complete Fig. 75-2, Articles of Incorporation.
   a. Use Transparency 143-2, *Articles of Incorporation*.
   b. Use the grease pencil to write names and other information needed on the transparency.
   c. Post one copy.

9. Each group of students will design a thumbnail sketch of a corporation trademark on 8½" x 11" paper.
10. Display the best design from each group and select one for the official trademark of the corporation. NOTE: This can be accomplished by taking the selected group designs to the chalkboard and having the class vote by a show of hands.

Note

1. Display the IACP Manufacturing Corporation Plant Layout on the bulletin board or mount it on a separate board. It is another form of a "cognitive map."
2. Announce the corporation now has a plant.
3. Reference should be made to the plant layout each day by pointing out where various activities are going on in the plant. For example, relate people to various offices, point out where the sales forecast is made, where records are kept, and where design and engineering is accomplished.
4. In the fabricating areas you may want to cut out benches and equipment and arrange the area to simulate the school laboratory production area.

Homework

Reading 72, *Locating the Plant and Securing Inputs*

Note

Cut out two or three stock quotations from a local newspaper. Make sure the quotes are for the same companies that you collected in Assignment 132. Save these quotes for use in Assignment 144.

ASSIGNMENT 144, ACTIVITY 76
READING 72

Locating the Plant and Securing Inputs

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on locating the plant and securing inputs:
   a. Name three specific examples of inputs of each of the following: natural resources, energy, and human resources.
   b. Name some inputs the community may *not* have that manufacturers would need in order to locate in the area.

Discussion

2. Given the problem of establishing and financing a corporation, name the most common way management obtains capital.

Laboratory Activity

3. Given the problem of securing capital to begin a corporation, issue the necessary number of stocks.
4. Sell stocks and complete stock certificate.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

2-3 copies of stock quotations from a local newspaper (at least one week between papers)
1 set Transparencies:
144-1. *Decisions to Make in Plant Location*
144-2. *Stock Market Index*

1 or 2 samples of stock certificates.
NOTE: It will help if the teacher preselects specific stocks and underlines these.

Supplies (Class)

150 $1.00 certificates (as simulated money)
25 stock certificates

Overview (5)

1. You have just formed and organized your corporation. An important part in the formation was electing officers and appointing a president.
2. You have read how the manufacturer identifies the six needed *inputs*: (1) natural resources; (2) energy; (3) capital; (4) finance; (5) human resources; and (6) knowledge. These items affect management's decisions on locating the plant.
3. I will tell you how manufacturers determine production costs and get money by the sale of stocks and bonds: this is the financial input.
4. You will be asked several questions concerning types of costs and stocks.
5. Today's laboratory activity deals with issuing common stock certificates to members of the class to obtain our necessary financial input. This is the most common way of financing a corporation.

Presentation (10)

Management has many decisions to make about inputs and plant location before a product and profit can be made. Knowing the amount of money needed to begin production, you must now consider how to raise this money.

1. A host of questions faces management in deciding where to locate a plant. Notice more than a dozen in this transparency. Show Transparency 144-1, *Decisions to Make in Plant Location*. Point out source of the major decisions.
2. Normally, total operating costs are found by adding the fixed and variable costs. Examples of fixed costs include overhead, buildings, and wages. Examples of variable costs might include materials, strikes, and sickness pay.
3. Once costs are determined, money can then be obtained by borrowing, loans, or by issuing common and preferred stock which you read about in your text.
4. Revenue from stock does not usually have to be repaid; therefore, it is like a loan with a due date that is infinitely far away.
5. Stocks are regulated by laws and custom.
6. Show a few newspapers that have the stock figures in them. Select one company's stock and compare the figures. It is suggested that there be at least a week's difference between the papers, so that the stock values will vary. Point out to the students how the value of a particular stock fluctuates. Show Transparency 144-2, *Stock Market Index*, for listing the stock to be studied.

Discussion (5)

The costs for producing the desk lamp must be known, and the money obtained, in order to operate the corporation.

1. What two main groups of costs are involved in producing the desk lamp? (Fixed and variable costs.)
2. How will you obtain the money for running your corporation? (By selling stock.)
3. What is stock? (A legal share in ownership of the corporation.)
4. What types of stock are usually sold? (Common and preferred.)

Laboratory Activity (25)

Today the students will calculate the amount of money needed to operate their corporation and issue the necessary amount of common stock.

1. The students will see ACTIVITY 80, Fig. 80-2, how much money the corporation would need. Here they are told it will be $81.00.
2. Using figures from that chart (Fig. 80-2), students will calculate the number of shares of stock needed for operating their corporation.
3. The students will complete the Articles of Incorporation charter started in ACTIVITY 75B.
4. The students will complete the issued certificates and exchange real or simulated money for the stock. Decide how you want the buying and selling of stock to be accomplished.

Note

1. Ask students to bring in some different colored and designed contact vinyl to

apply to the appearance mock-up in Assignment 146.

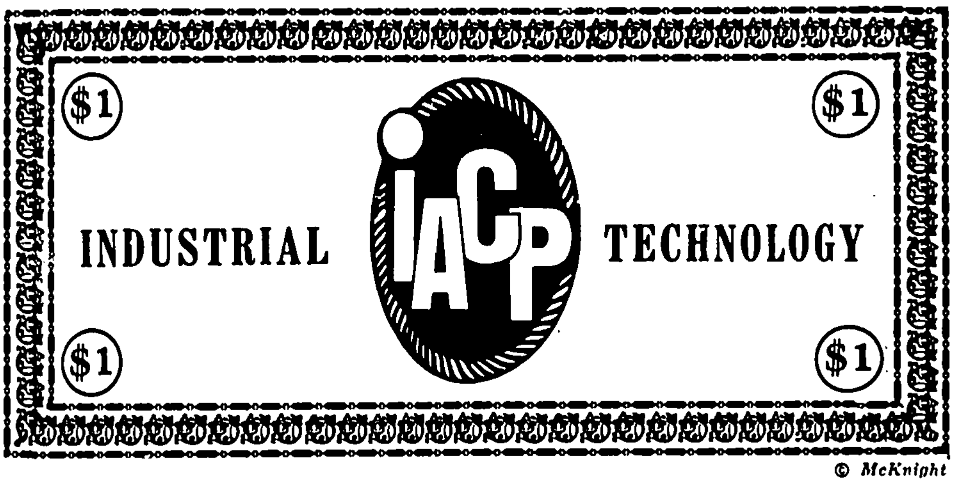
2. Some real stock certificates should be shown to the students.
3. Begin cutting stock to component size for the lamp activity. You might use graph paper to determine the best way to get the maximum number of components from each sheet of standard stock. Save the scrap strips which are 1¼" or more wide as these may be used to make strips of hanger bracket material.
4. Issue the simulated money before the activity, or set up a "bank" for students to get the money.
5. The bank (or the teacher) should keep the money until ACTIVITY 86 when it may be used to pay back a dividend.

Homework

Reading 69, *Relating People to the Corporation*

Note

Look ahead to Assignment 149, Fig. 149-1, to assemble instruction panels. Also see Fig. 149-4 to make jigs.



© McKnight

Fig. 144-1. Sample of Simulated Money

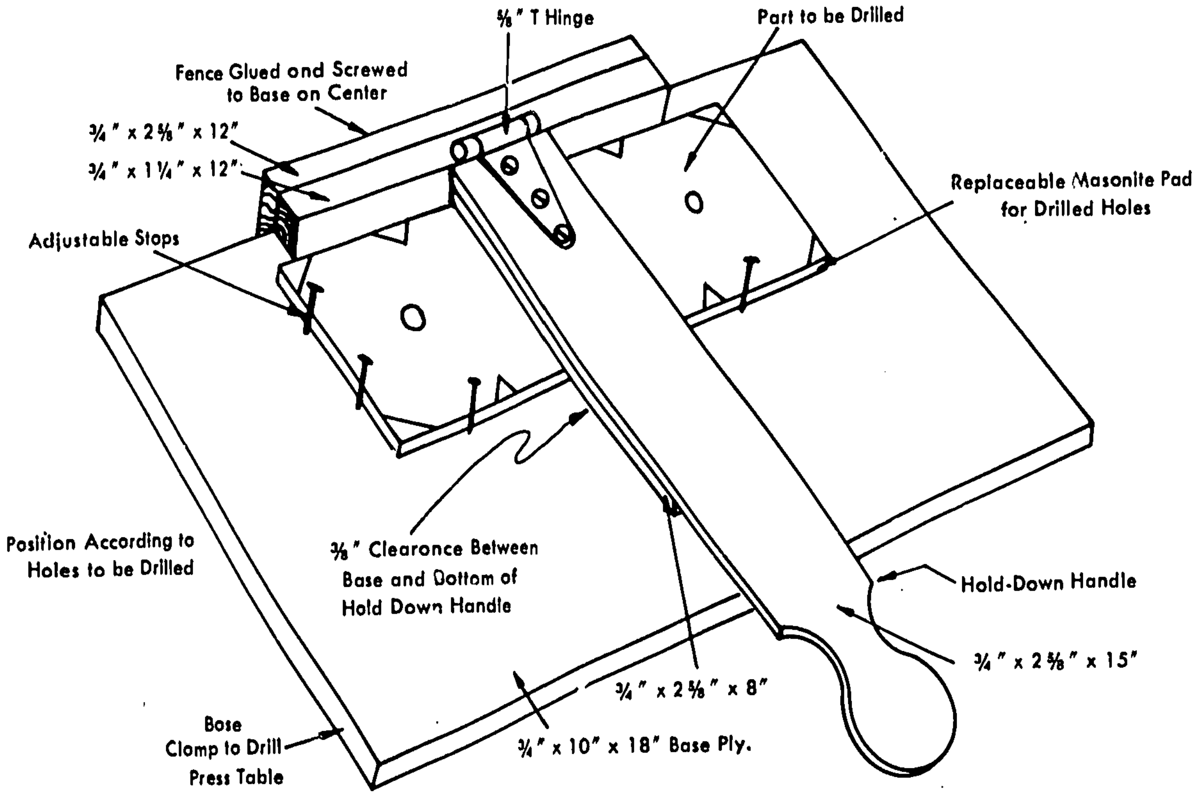


Fig. 144-2. Drill Fixture No. 149-1

This fixture is available in the official IACP equipment package from McKnight & McKnight Publishing Company, Bloomington, Illinois. However, you may construct a fixture using an alternate design.

ASSIGNMENT 145, ACTIVITY 77
READING 69

Relating People to the Corporation

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about relating people to the corporation:
   a. List three advantages of being a production worker, and list three advantages of being a manager.
   b. Look at the want ads in the local newspaper and determine if there are more job openings for managers or for production workers, and explain why this is true.

Discussion

2. Using the text reading and presentation, explain:
   a. The role of stockholders, directors, and a corporation president.
   b. The difference between wages and salaries.

Laboratory Activity

3. Given the task of structuring a corporation:
   a. Fill in an organization chart (chain of command) according to the names of students selected for each job.
   b. Fill out an employment application at the time students are selected for jobs.
   c. Compute accurately one week's payroll for the corporation.
4. Using a set of six photographs, classify those which represent management and those which represent production, and classify the production activities, as skilled, semiskilled, and unskilled.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1 overhead projector w/screen

Supplies (Class)

1 set Transparencies:
145-1. *Organization Chart*
145-2. *Employment Application*
30 shts. 8½" x 11" paper for computation

Overview (5)

Corporations try to hire personnel who meet the basic needs of the available jobs.

1. In our last assignment we formed a corporation.
2. Your reading for today described the personnel procedures for hiring, training, working, advancing, and retiring.
3. The presentation today involves the structure of the corporation: how it is organized, staff responsibilities, and the concept called *the chain of command.*
4. You will be asked about the responsibilities of stockholders, directors, and officers.
5. The laboratory activity will involve filling out an Employment Application, getting hired for a job, and filling in an Organization Chart. You will also compute one week's payroll for the corporation and use six photographs to identify production and management, then further break down the production item into skilled, unskilled, or semiskilled.

Presentation (10)

1. You have learned that corporations are set up by following certain legal steps.
   a. Three or more responsible people join forces to form a corporation.
   b. A legal *charter* granted by a state gives the corporation certain rights and privileges.
   c. A *board of directors* is elected to run the corporation.
2. Stocks are shares of *legal ownership* in the corporation. *Stockholders* are all the people who have invested their money in the corporation. They are entitled to vote for the directors. Usually one vote goes with one share of stock. NOTE: Transparency 145-1, *Organization Chart,* can be used in presentation Steps 2 to 7. By covering the chart and exposing those items in discussion, the "chain of command" will become evident. This

transparency also is similar to Fig. 77-1 in the Laboratory Manual.

3. *Stockholders* do not get paid unless they happen to work for the corporation, but they are entitled to share in the *profits* when the board of directors declares *dividends.*
4. The *board of directors* is a group of people elected by the stockholders. The directors' main job is to *run the corporation* according to the bylaws. This they do by setting company policy and by controlling the president.
5. The *directors* choose and hire the president of the corporation. They can fire him if they choose to. He has complete charge of the corporation and may run it in any manner he sees fit, as long as:
   a. The company makes a profit.
   b. He follows policy set up by the board of directors.
   c. He does not break the bylaws in any way.
6. A *line organization* is a way of organizing management people in a *"chain of command,"* similar to the army. This "chain of command" extends from the president and reaches the workers by passing through vice-presidents, superintendents, department heads, and foremen.
7. A "chain of command" can be shown on an Organization Chart. Everyone *takes orders* from those above him on the chart, and gives orders to those below him. In production, the worker gets the final order and carries it out.
8. The *staff* in an organization consists of people who have *no "command,"* no department under them. They can *only advise* others; they *cannot* give orders. The people in research and development can suggest to production and design people that a transformer-type, high-intensity lamp is better than a regular tungsten-filament lamp, but they cannot say "go ahead and produce it for sale."
9. Salaried workers represent management. Often they are paid on a yearly (annual) basis, or on a monthly basis. They often do not receive any payment for overtime work.
10. *Wages* are paid to *production* workers based on an hourly rate. (For example, $3.50 per hour.) Production workers are either *unskilled, semiskilled,* or *skilled.*

Discussion (5)

People are needed to make a corporation work.

1. Who are *stockholders*? (People who own shares of the corporation.)
2. Do they *run* the corporation? (No. They elect directors of the corporation who run it for them.)
3. What do the *directors do*? (Hire the officers. Set policy. Declare stock dividends.)
4. Why are *directors needed*? (The stockholders expect a profit. The directors must keep the company running efficiently so it will make a profit.)
5. What does the *president* of the corporation do? (Makes important decisions about all the inputs, the operation, and the products.)
6. What is a *wage*? (Money paid to production workers, usually based on an hourly rate.)
7. What is a *salary*? (Money paid to someone who is a manager or represents management.)
8. What determines a worker's classification as being unskilled, skilled, or semiskilled? (This classification is based on the amount of training and skill a person has. Skilled labor is highly trained and skilled for a particular job. An unskilled person has no special training or skill in any job. A semiskilled person is between the two.)

Laboratory Activity (25)

Today the students will choose individuals to fill the many positions in the corporation that need to be filled.

1. The board of directors and president, jointly, will appoint students to the management positions. These jobs are listed in Fig. 77-1, Organization Chart. The president, who was previously the agent, will select students for the production jobs. All the students will fill in Fig. 77-1 starting with the stockholders and progressing down through management and the production workers as they are chosen. Some positions will require more than one name, perhaps both in management and in production.
2. Show Transparency 145-2, *Employment Application.* Have the students fill out the Employment Application (Fig. 77-2) in the Laboratory Manual. Help them where necessary, using the transparency. SUG-

GESTION: To show the student an actual employment application, obtain an application for teaching from the superintendent's office or an application from a local industry.
3. Students will add the wages of workers below the executive level to the total of salaries to find the total weekly payroll.
4. If there is time, students classify from a set of photographs those which represent management and those which represent production and further classify production activities into skilled, unskilled, or semiskilled jobs.
5. Allow time for students to complete the questions at the end of the activity.

Homework

Reading 73, *Designing and Engineering the Product*

Answers for Laboratory Manual

Weekly payroll will vary according to number of production workers hired.

Problem 4 (Figs. 77-3 to 77-8):

77-3 a. Production
b. Skilled

77-4 a. Production
b. Semiskilled

77-5 a. Management
b. Stockholders

77-6 a. Production
b. Unskilled

77-7 a. Production
b. Skilled

77-8 a. Management
b. Officers

Questions

1. True
2. True
3. False
4. False
5. True
6. True
7. False
8. False

Note

Look ahead to Assignment 154. The teacher will have to make the inspection gages to be used in the fabrication of components.

ASSIGNMENT 146, ACTIVITY 78A
READING 73

Designing and Engineering the Product

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about designing and engineering the product:
   a. Look through today's newspaper and pick out the product you think was the hardest or easiest to design and engineer.
   b. Briefly explain why you picked the products as being the hardest or easiest to design and engineer.

Discussion

2. Given the process of designing a desk lamp:
   a. List the first and last steps.
   b. Explain the need for a soft mock-up.

Laboratory Activity

3. Given patterns of the lamp components, cut out and assemble the components to make an appearance mock-up of the lamp.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 set Transparencies:
146-1. *Rough Sketches of Possible Lamp Designs*
146-2. *Refined Sketch of a Lamp Design*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

4 prs. scissors

Supplies (Group of 5)

4 pcs. 9″ x 12″ postcard stock (.010″) *or* equivalent
1 pc. 8½″ x 11″ plain paper
1 roll masking tape
1 tube rubber cement
4 pcs. carbon paper
1 pc. ½″ x 12″ dowel rod
1 box crayolas *or* assorted colors of crayons
1 can spray paint, brown

Overview (5)

Through designing and engineering, a product idea becomes a real product that can be produced in a manufacturing plant.

1. Yesterday you filled in an application for employment and completed the organization of the corporation.
2. Your reading covered three main points.
   a. The marketing department and top management may analyze consumer survey information, as part of a feasibility study.
   b. Designing deals chiefly with problems of size, shape, and appearance of a product.
   c. Engineering solves problems of mechanical fit and performance.
3. You will see some sketches which illustrate how a product design begins, and I will talk about the major steps in manufacturing.
4. You will be asked questions about product designing and engineering. It will be important that you pay particular attention to this lesson.
5. Your laboratory activity will involve a part of the design process in which you will make an appearance mock-up of the desk lamp to be manufactured.

Presentation (10)

We will explore the main steps in designing a desk lamp for approval by management.

1. Several *thumbnail sketches* of the desk lamp are developed. Show Transparency 146-1, *Rough Sketches of Possible Lamp Designs*. These sketches suggested how the lamp *might* look.
2. Some thumbnail sketches are selected and *refined* into a *rough*. Show Transparency 146-2, *Refined Sketch of a Lamp Design*. Other thumbnail sketches are developed into *alternate* roughs.
3. Promising roughs are selected as a guide in making a *3-D model* or *mock-up* of the desk lamp.
4. The *external parts* (those that the customer will see) are identified.
   a. base
   b. shade (reflector)
   c. plug and cord
   d. stem
   e. socket
   f. switch
5. *Possible materials* for these parts are considered.
6. Information from the *market survey* is considered in developing design details.
   a. The general *appearance* must relate to what customers want.
   b. The lamp must *function* or be *useful*, in accord with customer needs.
7. A *3-D model* of the most promising design is presented to *management. Alternate* designs may also be presented.
8. *One design only* is possible for mass production because of the high cost of design and tooling. *When management approves* a specific design, engineering of the product can begin.

Note

The teacher may prefer to copy the outline of this presentation onto the chalkboard before class and keep the presentation brief.

Last semester the class learned about the *major steps in manufacturing a specific product*. They are reviewed here for the class.

1. *The product is designed.* Through sketches and models of various kinds, designers develop ideas about size, appearance, and suitable materials. Alternate designs may be developed. Finally management approves one design.
2. *The product is engineered.* Power elements are selected. Working drawings are prepared. A production prototype is built. The technical writing and illustrating for instruction manuals also may begin.
3. *Production is planned.* Decisions are made as to whether each part will be purchased or made in the plant. Operations are chosen. Route sheets and schedule sheets are developed.

4. *The plant is prepared for production.* "Tooling up" (everything involving tools and machinery) must be completed. Orders are placed for materials and parts which must be purchased.
5. *Production controls and quality controls are set up.*
6. *Production begins.* Some plants process raw materials into industrial materials. Some plants produce components from industrial materials. Some plants combine components into subassemblies or finished products. There are plants that produce components, subassemblies, *and* finished products. Sometimes packaging is the last production step.
7. *Selling, distributing, and servicing plans are developed and put into effect.*
8. Remind students that they are beginning this sequence of steps, and that many activities must be performed before actual production begins.

Discussion (5)

1. How does product design usually begin? (With notes and thumbnail sketches.)
2. What marks the end of the product design step? (Approval for production.)
3. Why make a 3-D model or appearance mock-up? (To help visualize the intended product.)
4. What three kinds of problems does designing solve? (Shape, size, and appearance.)
5. What two kinds of problems does engineering solve? (Mechanical fit and performance.)

Laboratory Activity (25)

1. Students will make an appearance mock-up of the high-intensity lamp.
2. Have the students work in their groups of five to select the best recommendation for improvement. Each foreman should present the recommendations agreed upon by his group.
3. Allow 15 minutes to cut out and make the appearance mock-up. Display the best one or two. *If time permits, it is suggested that students color the shade subassembly using spray paint or crayons.* Different colors of contact vinyl may be applied to the base bottom, stem, or any other component the teacher and class desire.

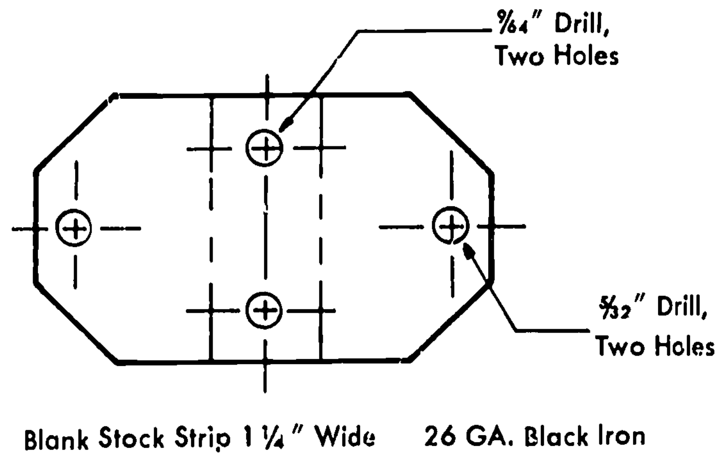


Fig. 146-1. Hanger Bracket Pattern

This is Fig. 78A-3 in the Laboratory Manual. The hanger bracket template (No. 149-1) is provided in the official IACP Lamp Kit package available from McKnight & McKnight Publishing Company, Bloomington, Illinois.

4. Students can transfer pattern pieces to the postcard stock by using carbon paper under the drawings of component parts found in the Laboratory Manual, Figs. 78A-1 through 78A-5. As an option, the teacher may have the fine component patterns dittoed. The patterns can be attached to the postcard stock using a limited application of rubber cement around the outer perimeter of each component pattern. See Figs. 78A-1 through 78A-5 in the Laboratory Manual.
5. A 1/2" x 12" dowel or a rolled-up piece of typing paper can be used to simulate the stem. The stem should be inserted through the hole in the base top and attached to the base bottom with masking tape.

Safety Precautions

Exercise care in the use of sharp-pointed instruments.

Homework

Reading 70, *Making the Sales Forecast*

Note

Retain the mock-ups for use in Assignment 147, Making the Sales Forecast.

ASSIGNMENT 147, ACTIVITY 79
READING 70

Making the Sales Forecast

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about making a sales forecast:
   a. Identify what kinds of data a breakfast cereal manufacturer must get before he decides to manufacture and market the product at a given price.
   b. Name a product now on the market that was not heard of five years ago and suggest why this product was developed.

Discussion

2. Given a presentation and questions, state purposes of a consumer survey and a sales forecast.

Laboratory Activity

3. Given a consumer situation, complete items on a survey form.
4. Given the results of a consumer survey, complete seven items of information from the survey forms and make a sales forecast.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 grease pencil
1 Transparency 147, *Survey Results*

Overview (5)

1. In the first semester, before you manufactured the (product for product-process R & D), you made a market research report and consumer survey to determine if there was a need for the product.
2. Yesterday you made an appearance mock-up which showed what the finished product would look like using various materials and colors.
3. Your reading pointed out that a market survey and a sales forecast help a corporation determine what it can best manufacture and sell.
4. You will learn how a corporation gets and uses marketing information.
5. You will be asked to describe a market study and a sales forecast.
6. You will have the opportunity to do market research and make a sales forecast.

Presentation (10)

A market study is needed to find out what kind of desk lamp the corporation should make.

1. Anyone can suggest a product for a corporation to manufacture, but it is the president who decides what products will be produced. Your corporation is considering various desk lamp models.
2. Because the president is responsible for making a profit for his corporation, he will carefully investigate the sales possibilities for desk lamps.
3. In addition to the kind of lamps the company can expect to sell, the president needs other data such as the price a customer is willing to pay, the number of lamps the public is already buying, and the uses for lamps.
4. The president must have facts; he cannot just guess at how well a desk lamp will sell. These facts come from market research.
5. Market research is usually done by experts in the field. These experts may conduct several different surveys for one product.
6. The data obtained from market research are used to make a marketing plan that outlines how the product will be sold.

Discussion (5)

1. What is a market study? (A study of consumers and what influences their decision to buy a product.)

2. What does a survey show? (Styles and types of products, also colors, sizes, prices, and other factors that affect a purchase.)
3. What is a sales forecast? (A prediction of what the corporation can expect to produce and sell, based on the market study.)

Laboratory Activity (25)

Students will conduct a consumer survey and complete a sales forecast.

1. The group foreman will conduct a survey within his group. He will record the results of the survey.
2. The foreman will report his results to the class. The teacher will record the results of all groups on Transparency 147, *Survey Results*. In industry, a computer would be used to compile the results.
3. The class will discuss the sales forecast (which lamp, how many, etc.).
4. Explain to the class that because this is a school activity, it was not practical to base lamp plans on the voting results. Tell the students that lamp "C" is the one on which future laboratory activities will be based. The people who prepared the laboratory activities had to choose one lamp, so the students would have one set of drawings and directions from which to work. Lamp "C" is a design that can be fabricated and assembled in an industrial arts laboratory. It can be assumed that on a material survey lamp "A" was chosen, even though on local surveys other lamps were selected.
5. As an optional or additional activity the teacher may have a discussion on what changes in color or design the students would suggest. Special consideration should be given to the reasons for the suggested changes, their effect on the cost of the lamp, the availability of material for suggested changes, and the difficulty of making the lamp if the suggestions are incorporated.

Homework

Reading 73, *Designing and Engineering the Product*

Note

Look ahead to Assignment 149. You will need 25 blanks cut to the correct over-all size for each lamp component used to make the prototype. Have duplicated copies of each component made before your demonstration.

Note

Check Assignment 149. You will need to prepare temporary drill fixtures. See Fig. 149-4.

ASSIGNMENT 148, ACTIVITY 78B

Designing and Engineering the Product

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a description and use of three kinds of drawings, and a prototype, identify the description of an assembly, detail, or exploded drawing.

Laboratory Activity

2. Given an exploded drawing with all parts numbered, and a partially completed parts list, fill in proper description of remaining parts.
3. Given an incomplete three-view drawing of a lamp, fill in the object lines, and supply the dimensions necessary to complete the working drawing.
4. Given a pictorial electrical drawing and electrical symbols, sketch an electrical schematic.

Time Schedule

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Equipment and Supplies for Presentation

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment

1 overhead projector w/screen

Supplies

1 Transparency 148, *Exploded View and Lamp Parts List*

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

5 12″ rules
1 soft lamp mock-up

Supplies (Class)

1 prototype of lamp

Overview (5)

1. Yesterday you made a sales forecast to determine the market for a high intensity lamp.
2. Today I will talk about several kinds of drawings. These drawings and certain data are needed so that production can be planned. They are part of the *designing* and *engineering* steps of our work.
3. You will be asked to name the kinds of drawings and the various kinds of information they provide.
4. In the laboratory activity you will use the information on an exploded drawing of the desk lamp to complete a parts list for it. You will finish a partially completed three-view drawing and sketch a schematic diagram of the electrical circuit.

Presentation (5)

Some kinds of information about a product can be shown best with drawings. Several kinds of working drawings and related data will be needed to *represent* the desk lamp you will make. (The teacher should put some of this information on the chalkboard.)

1. An *assembly drawing* shows how the desk lamp looks when put together.
2. An *exploded drawing* shows parts and how they fit together.
3. A *detail drawing* of a part shows the shape and gives the measurements needed to make the part.
4. A *parts list* will be needed. This is a complete list of parts for the desk lamp. It includes the parts to be manufactured and all parts which are purchased: nuts, bolts, plug, bulb, etc. Show Transparency 148, *Exploded View and Lamp Parts List.*
5. A *systems drawing* is different from *dimensioned drawings*. A systems drawing is *schematic*; it shows a scheme or plan, rather than sizes. An electrical schematic shows a skilled workman how to wire a circuit — for example, a lamp circuit.
6. A *set* of *working drawings* cannot be

made until the appearance and performance of the desk lamp are determined in detail. Every part must be designed to fit with every other part, and to function efficiently.

7. *Product engineers* are in charge of recording technical data. *Production planners* and others use the data.
8. One of the *last* steps in *engineering* a product is making the prototype. The *prototype* is a full-size *working* model of the proposed product.

Discussion (5)

Discuss with the class how *product engineers* record information about a desk lamp.

1. What kind of drawing will show how the lamp *looks* when it is put together? (An assembly drawing.)
2. What will show *all* the parts and the way they fit together? (An exploded drawing.)
3. What kind of drawing shows the shape and dimensions of one part? (A detail drawing.)
4. What is the name given to a full-size working model of the product, one of the last engineering steps? (A prototype.)

Laboratory Activity (30)

Today the class will complete a parts list and two drawings.

1. Students will match parts shown on an exploded drawing with part names on a chart, read the reference number for each part, and complete a parts list.
2. Some part names given in the Laboratory Manual do *not* specify sizes. The complete parts list printed in the Laboratory Manual, Fig. 78E-1, includes all size details for screws, pop rivets, etc.
3. Make available for Problem 2 the one lamp prototype you completed before class. Keep it at your workbench or other convenient place, so students can examine it and measure the overall height.
4. Give help, as needed, with any of the activities.

Homework

None

Answers for Laboratory Manual

Problem 1

1. Shade bottom

Designing and Engineering the Product

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

Given a pattern, templates, sheet-metal blanks, and the necessary tools, make five each of three desk lamp components: shade top, shade bottom, and hanger bracket for the prototype.

Time Schedule

5 Overview
20 Demonstration
20 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Class)

1	squaring shear
1	box and pan brake
1	bar folder, if available
1	center punch
1	prick punch or awl
1	ball peen hammer
2	4″ C-clamps
1	1/16″ twist drill
1	9/64″ twist drill
1	5/32″ twist drill
1	13/32″ twist drill
1	3/32″ twist drill
1	5/8″ twist drill
2	drill fixture No. 149-1
1	hanger bracket template No. 149-2
2	drill jigs for hanger bracket and lamp stem No. 149-3
3	temporary drill fixtures*
1	hanger bracket bending fixture No. 149-4
1	drill jig No. 149-5, for shade rivet holes
1 pr.	combination pliers
1 pr.	tin-snips
1 pr.	scissors
1	mill file, 8″ or 10″

1 drill press
1 pop rivet gun
1 set No. 5 Whitney Jr.® metal punch
1 hand notcher 90°

*These are ¾″ x 6″ x 18″ scraps with ¾″ x ¾″ wood strips glued and screwed to the face forming the outline of each component. See Fig. 149-4. These must be made before class-time.

Supplies (Class)

3 btl. rubber cement
6 pc. 26 or 28 ga. black iron 7½″ x 7¾″, component 1, shade top
6 pc. 26 or 28 ga. black iron 3½″ x 5½″, component 2, shade bottom
6 pc. 26 or 28 ga. black iron 1¼″ x 30″, component 3, hanger bracket
10 ⅛″ x ⅛″ pop rivets
6 duplicated copies of each lamp components 1, 2, 3
1 set Instructional Panels No. 149-1 to 149-11

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for one group of students, to demonstrate the procedure they will follow.

1. It is highly recommended that instruction panels be placed near work areas to guide each group in the manufacture of each component. The eleven (11) instructional charts are available from McKnight & McKnight Publishing Company, Bloomington, Illinois. The charts are printed on sheets that are 25″ x 38″. You will cut each instructional panel (follow the dotted cutline) from each sheet and mount it on plywood, cardboard, masonite, or poster board. Hang the instructional panel in a work area so each group can follow the production sequence of each component. Store the panels in a clean storage area at the end of the period.
2. Refer to these instructions during the demonstration and keep them readily available to the students at the work centers.
3. Assemble the Drilling Fixture Kit 149-1 supplied by IACP following the directions given in Assignment 144. See Fig. 149-2. The fixture might be improved or modified by the individual teacher. When drilling the 13/32″ and ⅝″ holes in the shade bottom and base top, be sure to use fixture 149-1 to securely hold the metal blanks. See Fig. 149-3. The fixture may be used to gang-drill 10 to 20 blanks at one time or may be modified to drill only one blank at a time. Drill near the handle of the fixture to prevent buckling. Put scrap metal, hardboard, or scrap hardwood under the blank to prevent a burr on the bottom blank. Move the scrap material after each hole has been drilled so that you do not drill into an existing hole. Other fixtures, Fig. 149-4, are used for drilling smaller holes in these and other metal components. If a burr is formed, it may be removed by using an electric drill with a sanding disc. If a metal punch is available, it should be used to punch as many of the holes as possible.
4. The paper templates should be cut with the object lines remaining. See Fig. 149-5. Apply the rubber cement sparingly to the outer edges of the paper template and component. See Figs. 149-6 and 149-7. Fig. 149-8 shows how the center punch is used to locate the center of the holes to be drilled. In order to do more accurate work, a metal template with 1/16″ locating holes may be used. See Fig. 149-9. CAUTION: If you choose to use the metal templates, make at least two of them and clearly mark them on both sides with a magic marker. Save the second template as a spare.
5. Make the three fixtures as shown (see Fig. 149-4), with the inside size being exactly the size of the component. The fixtures can be made of available scrap that is reasonably strong. One to 15 components can be held in the fixture for drilling with an electric hand drill. Be sure students hold the drill perpendicular to the metal, since any slant will result in inaccuracy. Be sure to clamp all sheet metal components securely so that they do not "spin" and endanger the students. A drill press will do more accurate work if it is available. The large holes must be drilled with the drill press.
6. When presenting the demonstration, try to arrange students so they can see what you are doing. If possible, involve students.
7. The teacher might see fit to appoint or employ students as supervisors or specialists in various areas. If the students elect these specialists, they generally are more effective. The teacher should explain

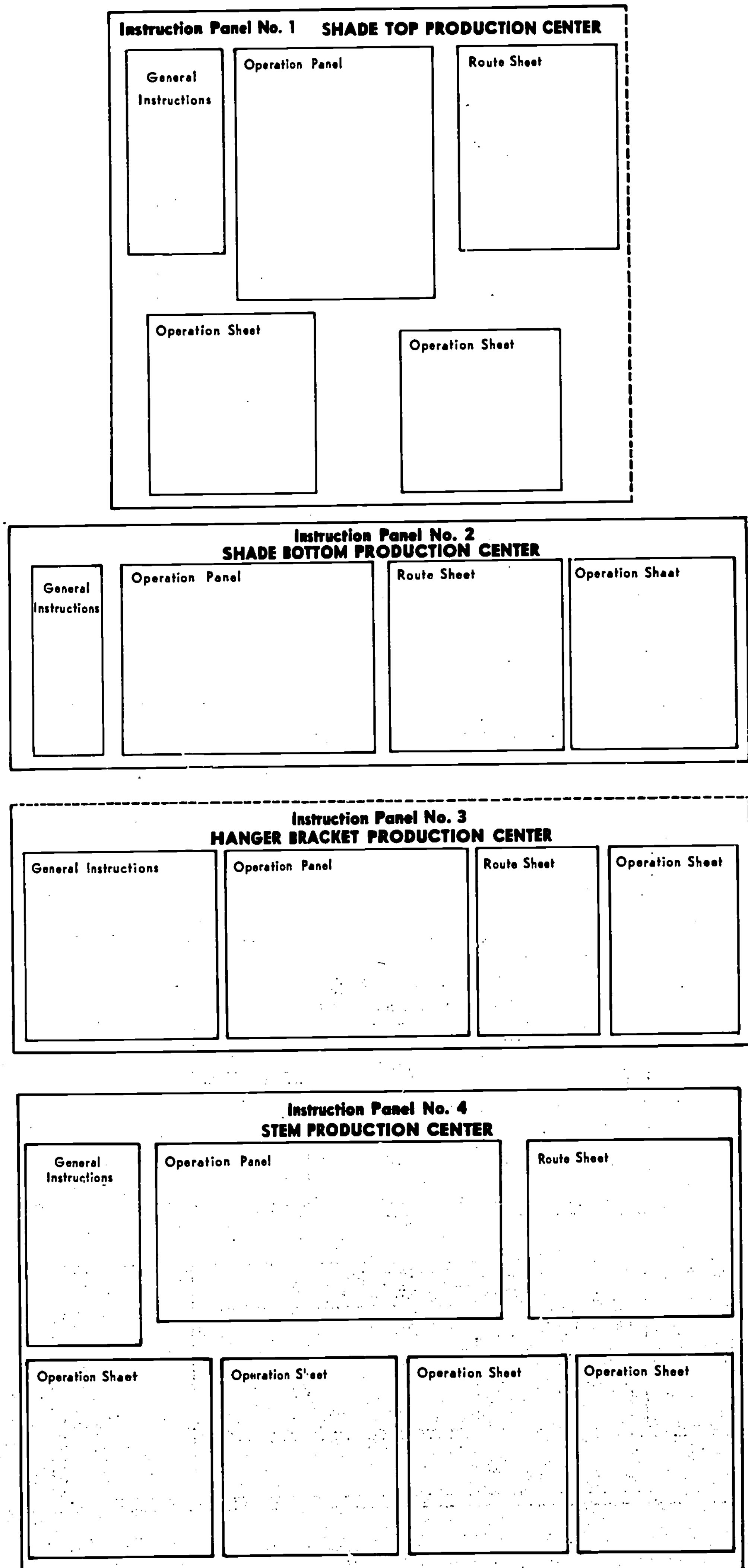
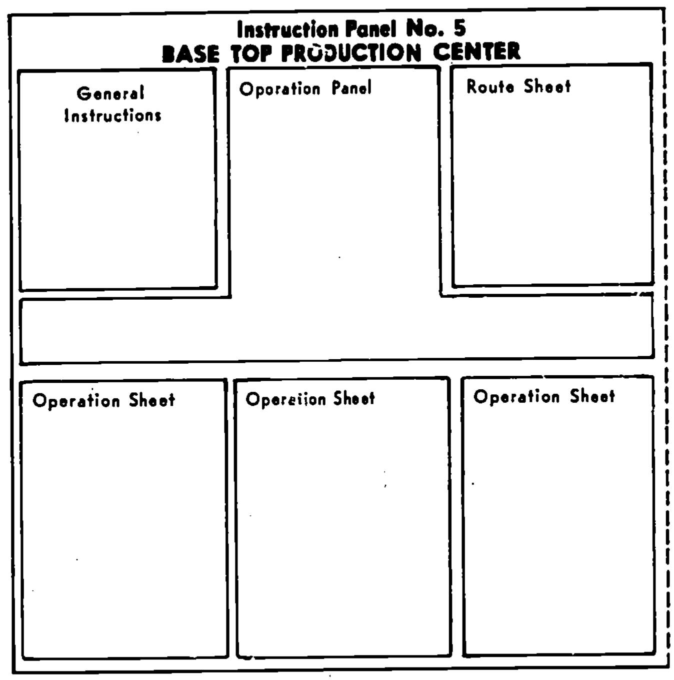
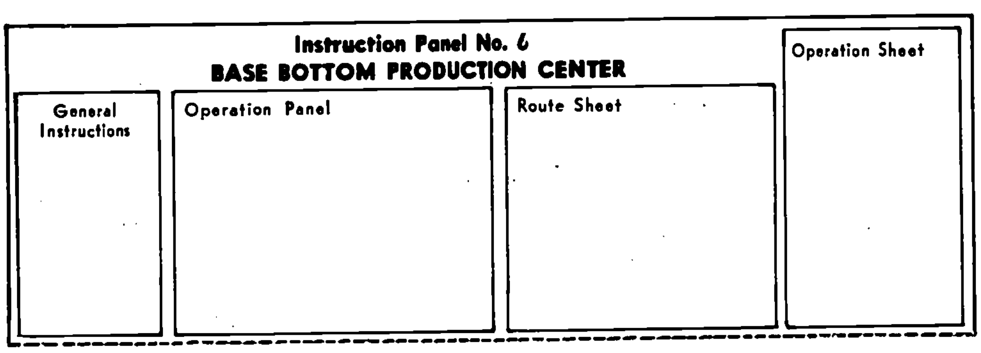
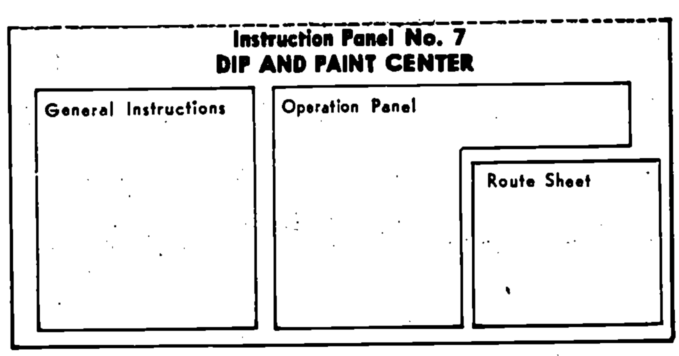
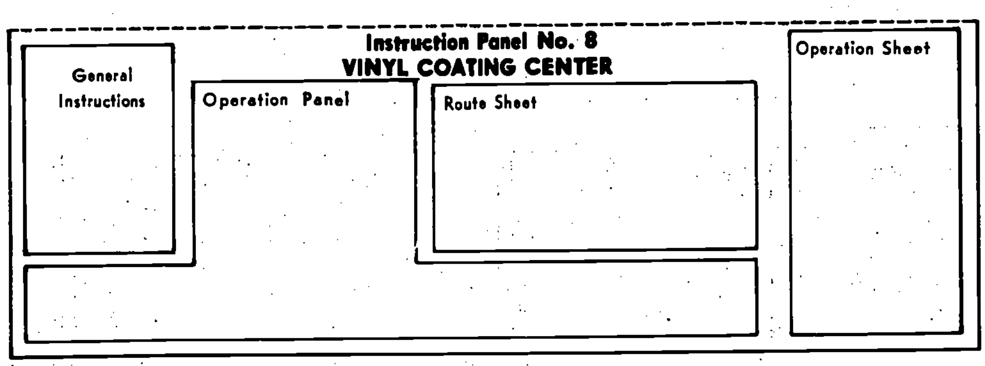


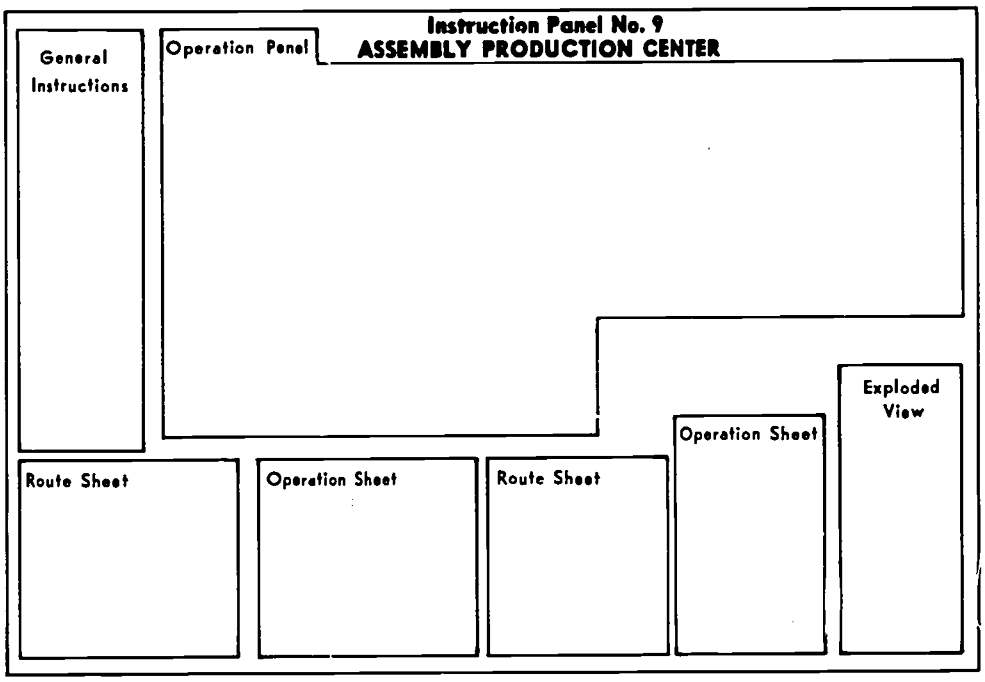
Fig. 149-1. Instruction Panels

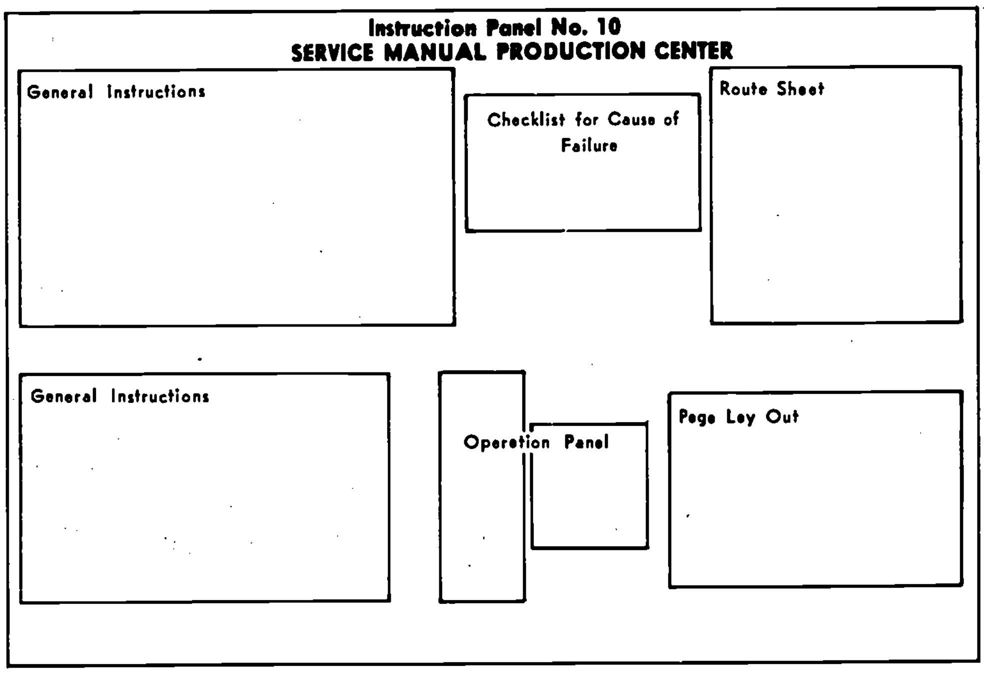

Instruction Panel No. 5
BASE TOP PRODUCTION CENTER
General Instructions
Operation Panel
Route Sheet
Operation Sheet
Operation Sheet
Operation Sheet

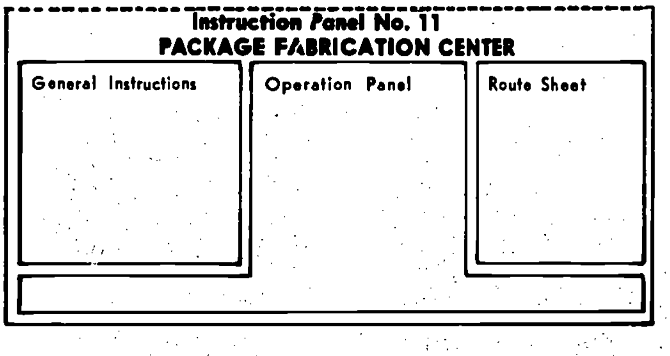

Instruction Panel No. 6
BASE BOTTOM PRODUCTION CENTER
Operation Sheet
General Instructions
Operation Panel
Route Sheet


Instruction Panel No. 7
DIP AND PAINT CENTER
General Instructions
Operation Panel
Route Sheet


Instruction Panel No. 8
VINYL COATING CENTER
Operation Sheet
General Instructions
Operation Panel
Route Sheet


Instruction Panel No. 9
ASSEMBLY PRODUCTION CENTER
General Instructions
Operation Panel
Exploded View
Operation Sheet
Route Sheet
Operation Sheet
Route Sheet


Instruction Panel No. 10
SERVICE MANUAL PRODUCTION CENTER
General Instructions
Checklist for Cause of Failure
Route Sheet
General Instructions
Operation Panel
Page Lay Out


Instruction Panel No. 11
PACKAGE FABRICATION CENTER
General Instructions
Operation Panel
Route Sheet

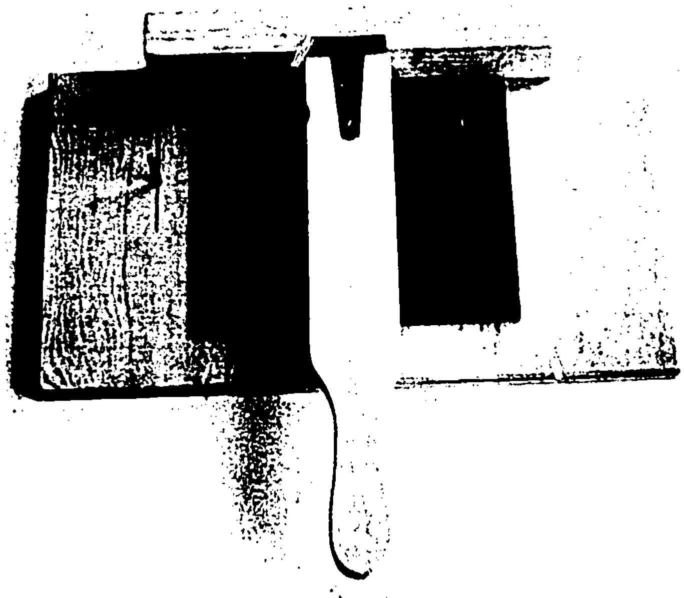


Fig. 149-2. Drilling Fixture No. 149-1

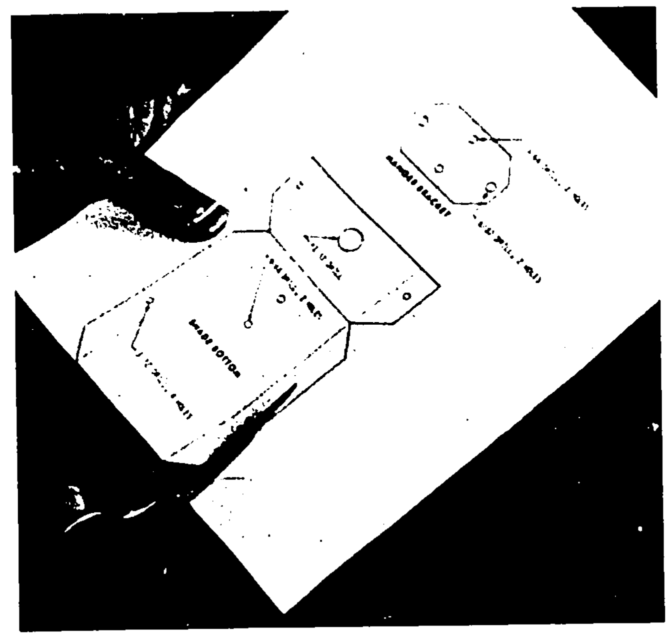


Fig. 149-5. Cutting Out Paper Template

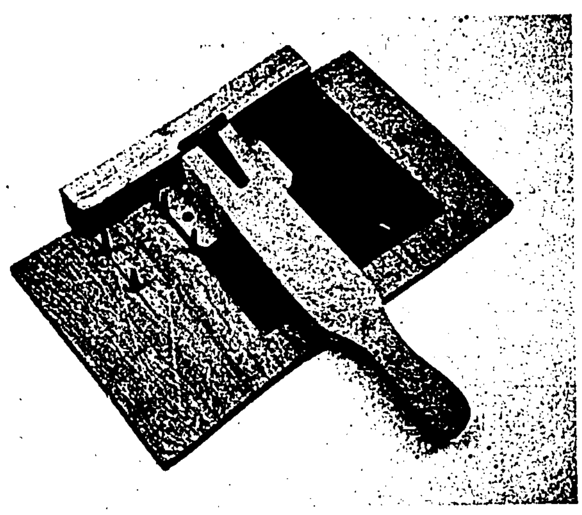


Fig. 149-3. Holding Blanks for Drilling Large Holes

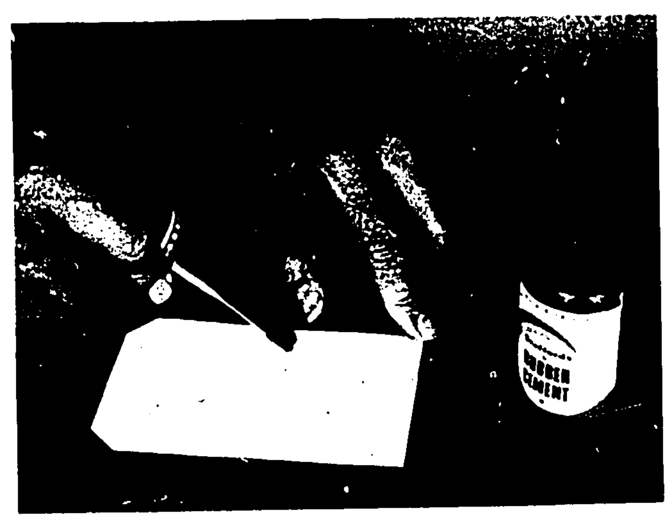


Fig. 149-6. Applying Cement to Template

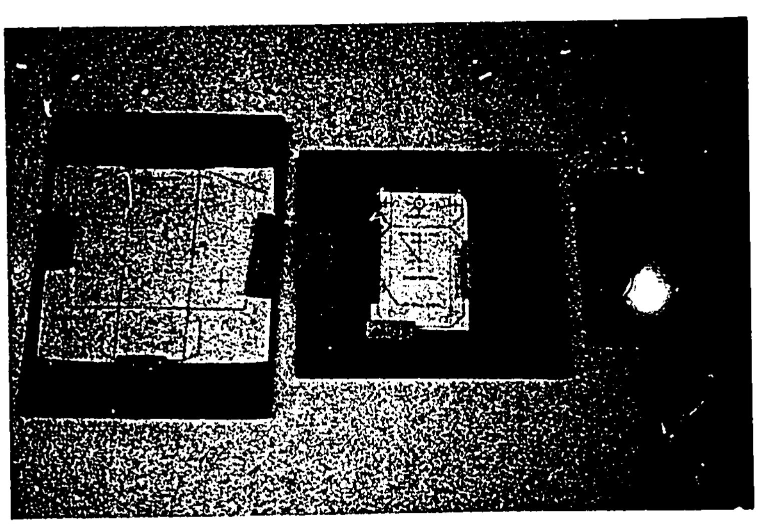


Fig. 149-4. Temporary Fixtures for Drilling Small Holes

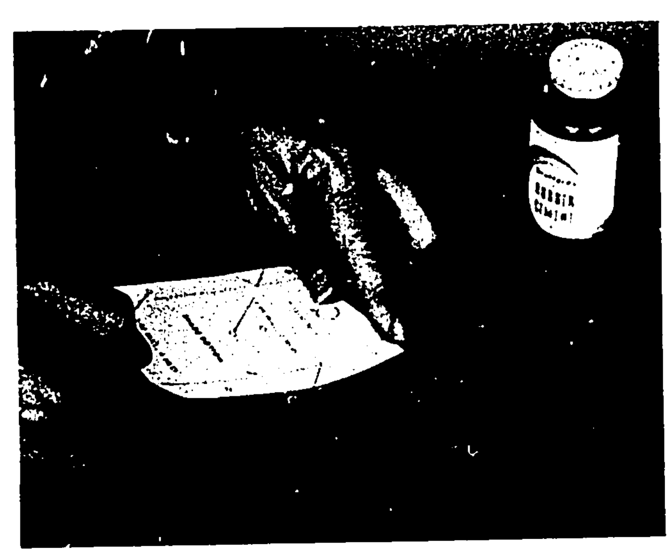


Fig. 149-7. Cementing Template to Blank

296

that he has the right to veto any selection made by the students.

8. Before class the teacher should check the switch and grommets to see if they will fit the designated holes. The suggested twist drill sizes will generally fit, but some components may vary in size, requiring changes in tooling.

Overview (5)

1. In your last activity, you made a parts list and a working drawing of the high-intensity desk lamp.
2. Today I will demonstrate the making of three of the components for the lamp.
3. Following the demonstration you will make five each of the three components that were demonstrated.

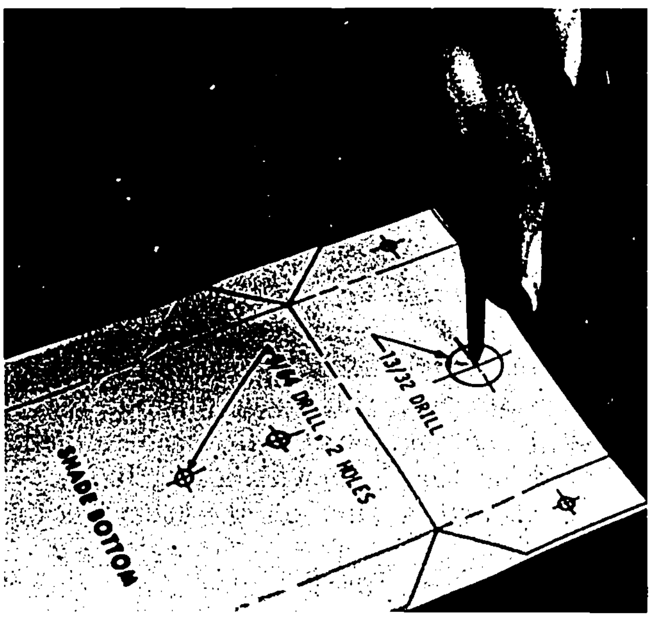


Fig. 149-8. Locating Holes with Paper Template

Demonstration (20)

The purpose of the three following demonstrations should be twofold. *First*, the demonstration should show the students how to properly use all tools and equipment in the production of lamp components in a safe and efficient manner. *Second*, the demonstrations should teach the students how to manufacture all components required to make a prototype. Teachers may find it necessary to change the order of the demonstrations described in Assignments 149 and 150. During the demonstration the teacher should deliberately and intentionally refer to the *INSTRUCTION PANELS* so the students will become familiar with them and with the production sequence. If properly done, this will alleviate the need to answer some questions.

1. Demonstrate cutting out the pattern and using rubber cement to attach the pattern to the component blank. See Figs. 149-5, 6, 7. Caution the students to apply only small amounts of rubber cement around the outer perimeter of the pattern and blank component. Cut out the notches according to the pattern.
2. Show the student how to use a center punch to mark the exact center location of the hole to be drilled by using either method shown in Fig. 149-8 or Fig. 149-9. The metal-punch template is drilled with a 1/16" twist drill.
3. Give special attention to the instructions on drilling the 13/32" holes in the shade bottom. Remind the students that in industry these holes and the component blanks would be die-cut in one operation. If a burr is formed, it may be filed as shown in **Fig. 149-10**.

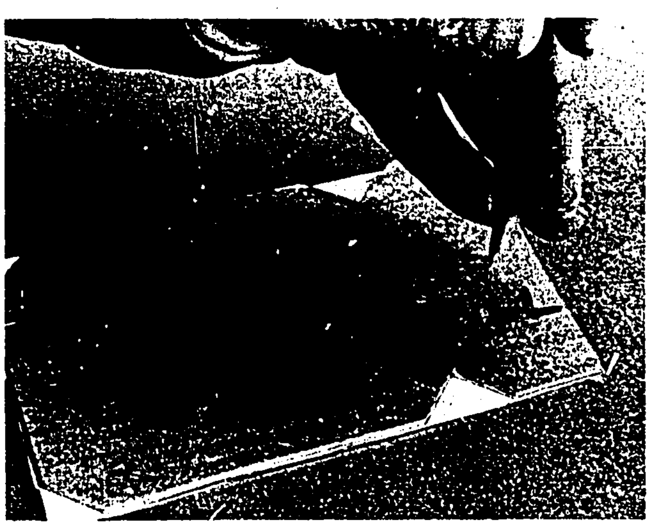


Fig. 149-9. Locating Holes with Metal Template

Fig. 149-10. Removing Burrs

4. Remind students that they must wear safety goggles while work is in progress in the laboratory.
5. Following steps 1 through 4, demonstrate to the students the proper procedure in making the shade top, the shade bottom and the hanger bracket. During the demonstration the teacher should employ the techniques he feels are most effective in his situation. *Refer to the instruction panels often.*

Laboratory Activity (20)

1. After the demonstration, divide the class into three groups. Assign one of the three component parts to each group. Have each group produce five component parts. These parts will be used later to make prototypes.
2. Provide each group with an instruction panel. Point out the use of the instruction panel. Students must follow the instructions very carefully. The foremen or the teacher may assign specific tasks to each group member.
3. Instruct students how and where to store incomplete components at the end of the first day's work.
4. Distribute equipment and supplies. Also, assign work areas.
5. Each group of students making sheet metal components will need five duplicated copies of the assigned pattern. All work must be done very accurately or the components will not fit together properly when assembled.
6. Monitor and correct procedures as necessary.

Safety Precautions

1. Safety glasses must be worn at all times, when using machines or tools.
2. Any metal being drilled at the drill press or with the electric hand drill must be held in place securely with clamps and fixtures.
3. Punch operation should replace drilling where equipment is available.

Homework

None

Instructions for Building and Using Drill Fixture No. 149-1 (Figs. 149-2 and 149-3)

1. This fixture has been developed to use in drilling the holes in the components of the lamp. It can be used in connection with all of the components in place of having a fixture for each separate component. It is designed to use on the drill press to hold the components while drilling the large holes, or it may be used to hold components to drill with a hand drill. The fixture may be mounted securely to the drill press table with two C-clamps or it may be bolted through the slots of the table.
2. This is a suggested design for the teacher to go by in making a holding fixture. The *fence, hold-down handle, hinge and screws will be provided.* The teacher will cut a piece of wood for the base. This may be made of ¾″ plywood or a hardwood. Suggested size is 10″ x 18″, but this may vary to fit your drill press table.
3. It is suggested that the fence be lined with a piece of sheet metal to keep the components from cutting into the fence. The base should be covered with a thin piece of wood or, preferably, ¼″ masonite. This will protect the face of the fixture, and you will be able to move the masonite each time you drill so there will be new material into which to drill. By doing this, you will be less likely to end up with a burr on the underside of the stock.
4. Provided are four $\frac{3}{16}$″ steel pins. These are to be used as stops for the fixture. $\frac{3}{16}$″ holes are to be drilled in the base to plug the pins in. The decision of where the pins will be located is left up to the individual teacher. Blocks of wood may also be screwed to the base and used as stops.
5. It is advisable to attach a piece of rubber material to the underside of the hold-down handle. This will help to grip the metal and hold it more securely.
6. This fixture is designed to hold one component, or it will hold several if the teacher so desires. This is ideal for gang drilling. In the designing of this fixture, 10 components were successfully drilled at one time.

ASSIGNMENT 150, ACTIVITY 78D

Designing and Engineering the Product

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given the patterns, templates, sheet metal, or tubing and the necessary tools, make five each of three lamp components for the prototype.

Time Schedule

5 Overview
20 Demonstration
20 Laboratory Activity

Equipment and Supplies for Demonstration and Laboratory Activity

Equipment

1 hacksaw
1 squaring shear
1 box and pan brake
1 bar folder (if available)
1 center punch
1 scratch awl
1 ball peen hammer
2 4" C-clamps
1 3/16" twist drill
1 1/16" twist drill
1 9/64" twist drill
1 5/32" twist drill
1 5/16" twist drill
1 13/32" twist drill
1 3/32" twist drill
1 5/8" twist drill
2 drill fixtures, No. 149-1*
1 drill jig No. 149-3
1 temporary drill fixture**
1 pr. tin snips
1 pr. scissors
1 mill file, 8" or 10"
1 round file
1 drill press
1 No. 5 Whitney Jr.® metal punch set
1 hand notchers 90°
1 pr. combination pliers
1 saw jig No. 150-1, for stem
1 squeeze fixture No. 150-2, for stem
1 drill jig No. 150-3, for stem
1 stem bending fixture No. 150-4

*See Fig. 150-1 for use of drill jig 149-1, drilling the base top. These are made from 3/4" scrap plywood and lumber.

Supplies

6 duplicated copies of each lamp component
1 btl. rubber cement
5 ft. 1/2" O.D. aluminum tubing Part 4, stem
1 pc. 26 or 28 ga. black iron, 4" x 9 3/4" Part 5, base top
1 pc. 20 or 22 ga. black iron, 7" x 8 1/2" Part 6, base bottom

Supplies (Per class)

3 btls. rubber cement
25 ft. 1/2" I.D. aluminum tubing Part 4, stem
5 pcs. 26 or 28 ga. black iron, 4" x 9 3/4" Part 5, base top
5 pcs. 20 or 22 ga. black iron, 7" x 8 1/2" Part 6, base bottom

Overview (5)

1. In our last activity you made the shade top, the shade bottom, and the hanger bracket for five prototypes.
2. Today I will demonstrate how to make the stem, the base top, and the base bottom. These are the three remaining components that will be needed to make the prototype. Carefully follow the instructions on your instruction panels.

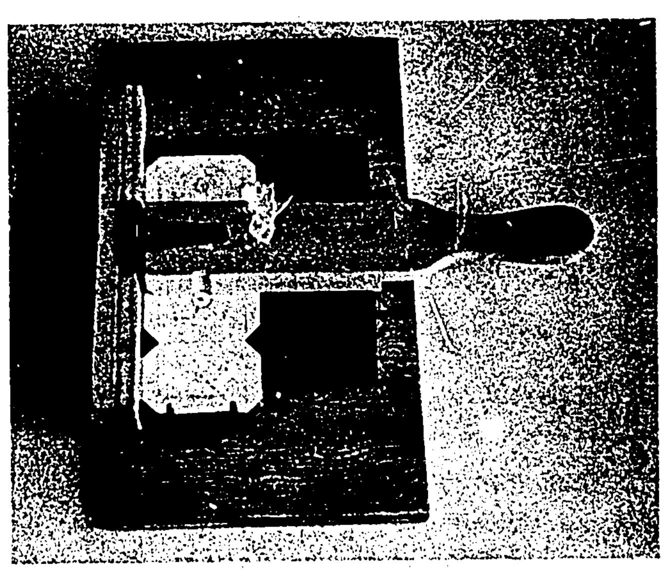


Fig. 150-1. Drill Jig 149-1 with Stock in Place

Demonstration (20)

1. Review the use of adhering the template to the metal blank, center punching, notching, and the reasons for clamping and holding the metal securely before drilling.
2. If a metal template is used instead of the paper template, *do not* attempt to use the template as a drill guide in place of center punching.
3. Using the appropriate template, fixtures, component blanks, and instruction panels, demonstrate how the stem, base top, and base bottom are to be made.
4. Caution students to wear goggles when using machines and tools.

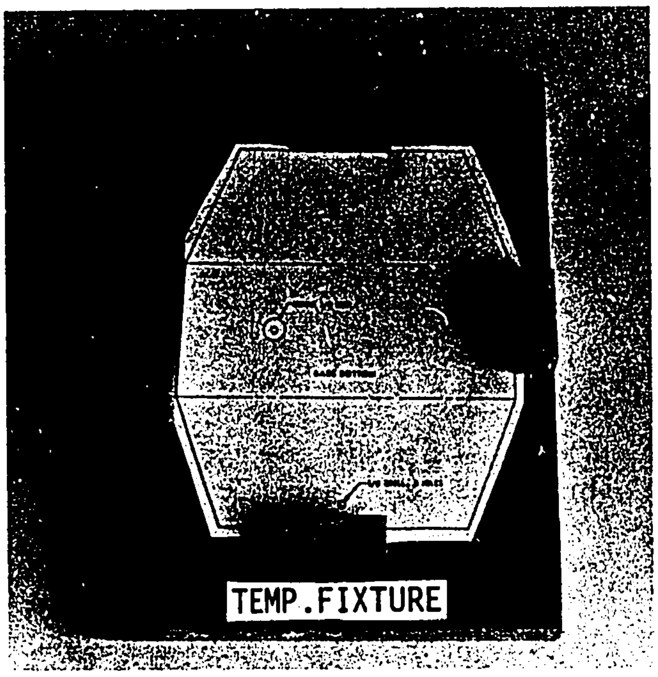


Fig. 150-2. Temporary Drill Fixture for Base Bottom

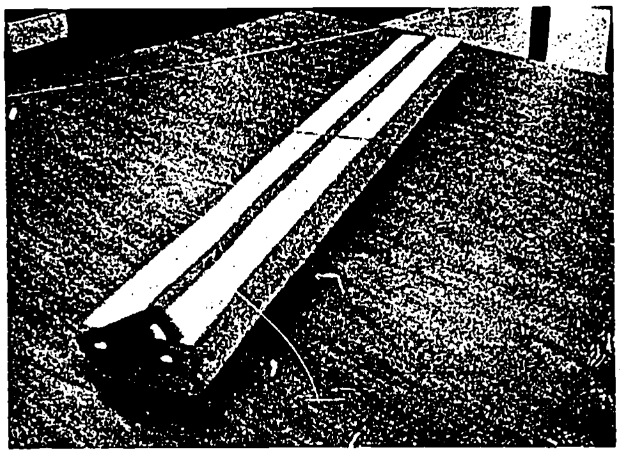


Fig. 150-3. The Official IACP Saw Jig No. 150-1 Equipment. Available from McKnight & McKnight Publishing Company, Bloomington, Illinois.

Laboratory Activity (20)

Today the students will make five each of three lamp components, the stem, the base top, and the base bottom.

1. Divide the class into three groups: Group 1 will manufacture five lamp stems; Group 2 will manufacture five base tops; and Group 3 will manufacture five base bottoms.
2. Have the students follow the demonstration instructions and the instruction panel.
3. When the components are completed, store them until the next assignment when they will be assembled.

Safety Precautions

1. Safety glasses must be worn at all times when using machines or tools.
2. Any metal being drilled at the drill press or with the electric hand drill must be held in place securely with clamps.
3. Punch operations should replace drilling whenever equipment is available.

Homework

None

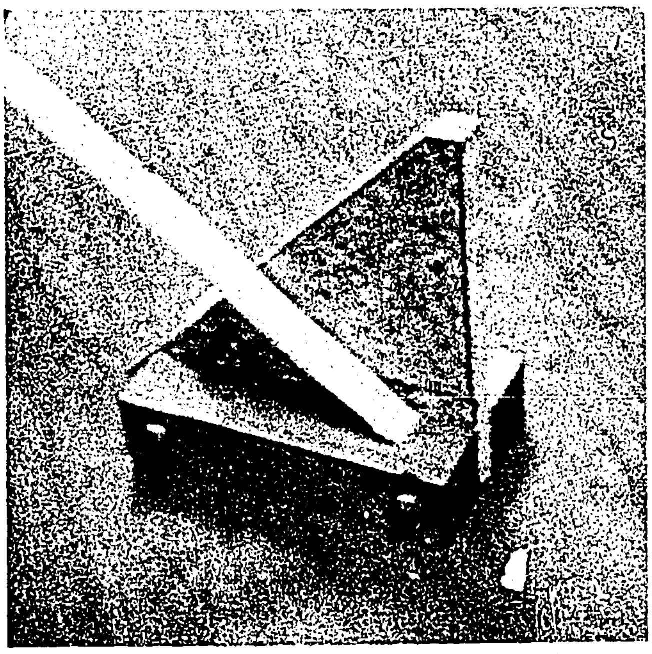


Fig. 150-4. The Official IACP Stem Bending Fixture No. 150-4 Equipment. Available from McKnight & McKnight Publishing Company, Bloomington, Illinois.

Designing and Engineering the Product

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

Given the six lamp components and other locally purchased components, combine them to produce five complete prototypes.

Time Schedule

5 Overview
20 Demonstration
20 Laboratory Activity

Equipment and Supplies for Demonstration

The teacher will use the equipment and supplies needed for one group of students to demonstrate the procedure they will follow.

Equipment and Supplies for Laboratory Activity

Equipment (Class)

10	screwdrivers, 4″ *or* 6″ blades
5	needle-nose pliers
5	bench knives *or* utility knives
5	diagonal cutters
5	wire strippers
5	adjustable wrenches 6″-8″
5	scribers
5	parallel jaw clamps

Supplies (Class)

5 ea.	lamp components 1 through 6
5 pcs.	No. 18-2 brown lamp cord, 7 ft.
5	brown snap-on electrical plugs
10	No. 72 B wire nuts, small
5	6-A, 125-V canopy switch, rotary, single-pole
5	75-W, 250-V socket, base for high-intensity bulb
5	40-W, 120-V bulb, high-intensity
5	½″ rubber grommet, ½″ I.D., ⅝″ O.D.
5	¼″ rubber grommet, ¼″ I. D., 13/32″ O.D.
5	½″ x ⅜″ dia. nipple w/hex nut
5	steel washers for No. 6-32 machine screws
5	No. 6-32 x ½″ FH machine screws
5	hex nuts, No. 6-32
5	No. 6-32 x ¾″ RH machine screws
5	wing nuts, No. 6-32
30	No. 6 x ¼″ pan-head sheet metal screws
2 pcs.	⅛″ pegboard, 12″ x 12″, for spray-painting screw heads

Overview (5)

1. During the past two days, each group has manufactured five components for a lamp prototype.
2. Today I will demonstrate how the lamp is to be assembled; then each group will assemble one prototype. As an alternative, the class may be organized into an assembly line to produce five prototypes.
3. The next day is an optional day and part of it may be used to complete this activity if necessary.

Demonstration (20)

1. Demonstrate the assembly of the lamp, referring to the instructions and illustrations on the instruction panels, if necessary to help the students understand the procedure.
2. Caution the students that there should not be any exposed wires in the socket or switch installation.
3. Caution students to cut only one wire when cutting the lamp cord for wiring the switch. During the socket assembly the teacher should inspect the socket subassembly before it is snapped shut. He should also inspect the switch to see that it is properly wired before the base subassembly is completed.

Laboratory Activity (20)

Today each group of students will make one lamp prototype using the components manufactured in Assignments 149 and 150.

1. The teacher should inspect the assembly after the socket has been wired, before the shade top is attached to the shade bottom.
2. Inspect the switch assembly before the base bottom is attached to the base top.

3. After the lamp has been completely assembled, the students should test to see that the bulb lights and the switch works.
4. Clean up the work area and return the tools.
5. Designate an area where the lamp prototype may be stored. Later, it may be disassembled, coated, reassembled and sold.
6. If students are unable to complete the assembly of the lamp today, use part of the following optional review day.

Safety Precautions

1. The teacher should inspect the socket after the wires have been attached but before the socket is reassembled. If possible, test the circuits without "snapping" the socket, since they are very difficult to disassemble. Do this in the prototype only.
2. The teacher should inspect the switch just before the wire nuts are attached. After this inspection the base subassembly may be completed.

Homework

Reading 71, *Obtaining Capital, Estimating Profit, and Keeping Records*

ASSIGNMENT 152, ACTIVITY 80
READING 71

Obtaining Capital, Estimating Profits, and Keeping Records

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about obtaining capital, estimating profits, and keeping records:
   a. Explain where one would look to find the names of lending organizations in your community, and list some that you find that lend money for starting a corporation.
   b. Look in the financial (business) section of the local newspaper and list three corporations that are trying to raise money through the sale of bonds and list three that are trying to raise money through the sale of stock.

Discussion

2. Given the concept "break-even":
   a. Explain what it means.
   b. Explain how a break-even chart is used.
3. Given the concept "Balance Sheet":
   a. State some kinds of information that may appear on a balance sheet.
   b. Explain the difference between assets and liabilities.

Laboratory Activity

4. Given cost and production figures, study how a break-even chart was arrived at and profits were estimated.
5. Given a balance sheet, study how the financial conditions of a company can be determined.

Time Schedule

5 Overview
25 Presentation
10 Discussion
5 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 set Transparencies:

152-1. *Break-Even Chart for a Lawnmowing Problem*
152-2. *Production Cost Analysis, Break-Even Chart*
152-3. *Balance Sheet — Completed*
152-4. *Balance Sheet — Blank*

Overview (5)

1. In the last few class meetings we have fabricated prototypes of our lamp. These prototypes represent a true-size working model of the final product.
2. In the text you have read about capitalization (determining how much money a new corporation will need and where and how to get it), profits, and corporation record keeping.
3. In the presentation today I will explain break-even charts and review two types of balance sheets.
4. You will be expected to answer questions in our discussion of the presentation material covering break-even charts and balance sheets.
5. You will be asked to supply missing terms for some problems in the Laboratory Manual.

Presentation (25)

Part I — Analyzing Capitalization and Estimating Profits

1. Show Transparency 152-1, *Break-Even Chart for Lawnmowing.* In the Laboratory Manual, have the students look at Fig. 80-1, Lawnmowing Break-Even Chart. Read the "lawnmower" example in the Laboratory Manual to the class and follow the problem outline on the transparency as well as in the Laboratory Manual.
2. Emphasize that the initial investment of $50 for the mower and $10 for gas and oil spent over 20 lawns represents *NO* income. Money earned up to the first 20 cuttings must all be paid out to debtors or persons from whom the money was borrowed. In the same way corporations are begun by borrowing money or selling stock to "get started."
3. Point out the break-even point as you read along in the problem to the class in the Laboratory Manual. Tell the class *no* money is "made" *before* that point. Their *profit* begins only *after* that point is reached.
4. Emphasize that a profit *begins after* the break-even point is reached. Ask the class, "What is the profit after 25 lawns are cut?". ($12.50) Ask the class, "What profit can be expected after 15 lawns are cut?" (None). Again point out the need of reaching the break-even point.
5. Now I will show you, step-by-step, the way a break-even chart is constructed. Locate each point in Fig. 80-2 as it is mentioned.
6. Show Transparency 152-2, *Production Cost Analysis*, and point out lines as they are mentioned. On the sample break-even chart there are *three fixed expenses*: *wages, salaries,* and *overhead.* Each of these expenses was found to be $10.00. On the chart find the three shaded strips that run straight across (horizontally). The top of the third strip is at the $30 mark. This represents the total amount of fixed expenses.
7. The company *estimated* that they would sell 30 lamp units. Along the top of the chart find the line which shows 30 lamp units. (Line E-E.)
8. Management found that the cost of *materials* for *each* lamp unit would be $1.70. This cost was multiplied by the 30 lamps to be produced. The price of the product was then *$51.00.*
9. Going straight up (vertically) from the point that shows 30 lamps units, the material cost of $51.00 was *added to the total* of the *fixed* expenses. Which point shows $51.00 plus $30.00? (Point B.)
10. To find the "Cost and Profit" line, run your pencil point vertically up line 30 or E-E, from zero to $81.00. Is $81.00 straight across from point B? (Yes.)
11. On the "Cost and Profit" line the top of the shaded area is labelled Point *A.* Points A and B are connected with a straight line, called line AB. By following this line the *cost* of manufacturing *any number* of lamps (from 0-35) can be easily determined.

12. The $81.00 was divided by the number of lamps to be sold, 30. This gives $2.70, the cost per lamp. The $2.70 is the cost of *wages, salaries, overhead,* and *materials* for each lamp when *30* units are produced and sold per week.

Note

The price per lamp will vary according to the quantity produced per week. It will go *up* with *fewer* units, and *down* as *more* units are produced.

13. If 30 lamp units are made per week, they cost $2.70 each. The company wanted a 20% profit. To find 20% of $2.70, multiply: $2.70
    x .20
    $ .5400

    The *profit* they wanted was $0.54 on *each* lamp.
14. Adding *cost* plus *profit* gives the retail, or store price, or $3.25 per lamp.
15. For 30 lamps the total retail price would be 30 x $3.25 = $97.20, Point C.
16. This figure, $97.20, was plotted as Point C on the sample chart, directly above Point B.
17. The points 0 (zero) and C were then connected with a straight line, called 0C. This line shows the income from the *sale* of any number of lamps, from 0-35.
18. The point where lines AB and 0C cross is called the break-even point. Ask the class to identify this point. (Point D)
19. This company will break even when the income from the retail *sales* of lamps *equals* the *cost* of producing the lamps sold. The sample chart shows that 20 lamps retailing at $3.24 must be sold *before* the company starts to make a *profit*. Because this is a short run, the profit increases with each lamp sold *after* the break-even point is reached. It equals 20% per lamp when the last lamp, the 30th, is sold. On a long production run, profit would "level off"; that is, the percent of profit would rise to 20%, and then stay at 20% — no matter how many lamps were made and sold, as long as the rate of production remained the same.

Part II — Keeping Corporation Records

1. To conduct a company's activities wisely, management must know its financial condition from time to time. Information about finances is gathered periodically: once a month, once every three months, or once a year. The summary, or report, that shows the financial condition of a company at a particular time is called a *balance sheet.*
2. There are *two* common types of balance sheets. One is the *record form.* Show Transparency 152-3, *Balance Sheet — Completed Record Form.* Read aloud the list of *assets,* on the top, and *liabilities,* on the bottom, so your students will hear the correct pronunciations. Define assets and liabilities briefly. Compute the corporate worth. Have students do it first in their Laboratory Manuals. See Fig. 80-3.
3. The other type of balance sheet is often called an *account form.* Show Transparency 152-4, *Balance Sheet — Blank Account Form,* and leave it on the screen. This is the form that you will talk about and discuss with the class.

Note

The students have the following problem (Fig. 80-3) with the same wording in their Laboratory Manual. Have them follow it in their Laboratory Manual, as well as following your reading of the problem. Use Transparency 152-4 to point out as many of the steps as time will permit.

4. *Current Assets.* All goods of any value, cash, bills owed to the company, materials on hand, supplies on hand, that may provide an income for the company in the near future are classified as current assets.
5. *Cash.* Cash includes currency, checks, bank drafts, and money orders. Here you would list the total amount of all income received from the sale of lamps that fits the items listed.
6. *Accounts Receivable.* An account receivable is a claim against a person or company. You would list all monies owed to the company by those who have received a lamp, but have not yet paid for it.
7. *Materials.* Materials include all items to be used in manufacturing a product. List the value of all materials *on hand* for the lamp.

8. *Merchandise Inventory.* The merchandise inventory consists of all products on hand that are ready for sale. You would list the total retail price for all lamps which you have not yet sold.
9. *Total Current Assets.* When all the current assets are added, the sum is called *Total Current Assets.*
10. *Fixed Assets.* These are all the permanent, physical items used by the company: buildings, land, equipment, etc.
11. *Buildings.* If a building is owned by the company, it is listed as a fixed asset. If a building is rented or leased by a company, the value of the building does *not* appear on the balance sheet because it is not the property of the company.
12. *Land.* The value of land owned by a company is listed as a fixed asset. When the land is rented or leased by a company, the value of the land does not appear on the balance sheet because it is not the property of the company. A company's land is listed separately from the buildings, since a building can decrease in value, but land will usually remain the same or increase in value.
13. *Delivery Equipment.* Delivery equipment includes trucks and other equipment used in delivering goods to customers. The total current value of these items would be listed.
14. *Manufacturing and Office Equipment.* All equipment in the company's plant and office would be included here. The current value of the equipment would be the basis for figuring its worth.
15. *Manufacturing Tools.* All tools used in the company to produce its product would be included here. The total current value of these items would be listed.
16. *Total Fixed Assets.* When all the fixed assets are added, the sum is called *Total Fixed Assets.*
17. *Total Assets.* When the two groups of assets, total and fixed, are added, the sum is the *Total Assets* of the company.
18. *Liabilities.* Liabilities are debts charged against the company, such as taxes, salaries, wages, etc.
19. *Accounts Payable.* Accounts payable are financial obligations, money the company owes, for purchases. For your lamp company we will assume that it is money owed for materials and supplies.
20. *Salaries Payable.* Salaries payable are all the monies owed to employees of the company for all types of service.
21. *Unearned Income.* Unearned income is money received in advance for goods or services which have not been provided to date. For example, you would list all money received for lamps which you have not delivered at this time.
22. *Overhead.* All the fixed costs of operating a company are combined as overhead. Such items as property taxes, electricity, gas, and heat might be included. Overhead will be discussed in ACTIVITY 81.
23. *Total Liabilities.* When all the liabilities are added, the sum is called *Total Liabilities.*
24. *Surplus or Loss* (not shown). The surplus or loss would be the difference between the total assets and the total liabilities. This could be a plus or minus figure. It would show the gain or loss due to the company's financial operations for the period of time being checked.
25. *Capital Stock* (not shown). Capital stock means the total original investment made by all the stockholders in a company. You would list the total amount of money received from the sale of stock. When you registered the incorporation with a state official, you recorded this amount as capitalization.
26. *Total Equity* or *Corporate Worth.* The addition of the surplus to the capital stock will give the total equity, or what the company is worth.

Discussion (10)

1. What does *"break-even"* mean? (Not losing any money and not earning any. Expenses or costs and income or earned monies match exactly.)
2. When is a *profit* made? (*After* the break-even point is reached and passed. It may be weeks, months, or years after production has started for some companies.)
3. How does the break-even chart help a company or its president decide whether or not to make a new product? (The break-even chart will tell the president *how long* the company must produce the item *before* it will start making a *profit.*)
4. What is a *balance sheet*? (It is an accounting record; it tells if the company is making a profit or *losing* money in a particular period of time.)

5. What is one difference between the terms *assets* and *liabilities* on the balance sheet? (*Assets* represent items on a balance sheet showing the book value of items *owned; liabilities* represent what is *owed.*)

Laboratory Activity (5)

Before the end of the period, allow time for the students to answer the questions in their Laboratory Manual. Review the answers with the students.

Homework

Reading 74, *Planning Production Processes*

Answers for Laboratory Manual

1. Potential
2. High or low
3. Market
4. Government
5. Money
6. Current assets
7. Fixed assets
8. Liabilities
9. Balance sheet
10. Liabilities

ASSIGNMENT 153, ACTIVITY 81
READING 74

Planning Production Processes

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on planning production processes:
   a. Look at a pencil or pen and list the processes used in the manufacture of that product.
   b. Write a schedule for the activities (processes) you did this morning in getting dressed and ready to go to school. Study the schedule and see where changes can be made to increase the efficiency of the processes. Follow the new schedule tomorrow and compare the efficiency.

Discussion

2. Given a presentation on planning production processes:
   a. Supply the name for a chart that describes the sequence of production processes.
   b. Name the steps in making a route sheet from information on a process flowchart.
   c. Name three kinds of information needed on an operation sheet.

Laboratory Activity

3. Given the proper forms and the directions:
   a. Complete a production center flowchart.
   b. Complete a process flowchart.
   c. Complete a route sheet and list processes.
   d. Select the main step in the sequence of the operations in the lamp base drilling operation sheet.

Time Schedule

5 Overview
15 Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 set Transparencies:
153-1, *Production Process Flowchart*
153-2, *Route Sheet*
153-3, *Operation Sheet*
1 roll tape
1 Chart 153-1, Production Process Flowchart
1 Chart 153-2, Production Sequence for ACTIVITY 81

Overview (5)

1. The last lesson dealt with estimating profits and keeping records for a corporation. A break-even chart was studied and you were able to decide how many units needed to be made before a corporation could begin to realize a profit.
2. Your reading for today concerned the planning of production processes. You learned that the:
   a. *Production planner* is in charge of all production-planning activities.
   b. *Methods engineer* is in charge of efforts to simplify operations and improve efficiency.
   c. *Work-measurement engineer* is skilled in time-and-motion study. His data provide the methods engineer with information to help improve production methods.
   d. *Tool engineer* is in charge of tool control and tool maintenance.
   e. *Cost estimator* provides information that helps select the most economical method of production.
   f. Specialists all provide information needed in planning production.
3. I will explain in detail how you, as production planners, will plan some of the procedures for producing the high-intensity desk lamp.
4. You will be asked to describe a process flowchart, a route sheet, and an operation sheet.
5. In the laboratory activity you will complete a production center flowchart, a process flowchart for the base bottom, and a route sheet. You will examine an operation sheet.

Presentation (15)

Production planning is essential before efficient manufacturing can take place. Tools and machines must be provided. There must be a well-organized plan for assigning people to production tasks.

1. First, a *production planner* has to determine *how* a product can be made. He decides what processes the materials must go through, and in what order these processes must take place. For example, the metal components you manufacture for the lamp will be coated *after* they are formed, but *before* they are combined in subassemblies.
2. There are so many components to the desk lamp that require many various operations that we could not possibly make a complete production run without developing an organized plan of production. Still more important, we could not work together effectively without a plan that we can all read and understand. Display wall charts No. 153-1 and No. 153-2 for the class. Transparency 153-1 will later be used to show the detailed process of the base bottom.
3. The easiest way we can formulate a production plan is to make a process flowchart. At this stage you are *production planners*. You can easily determine what major components are included in the desk lamp, so you can start planning by listing these components on a horizontal line. Show Transparency 153-1, *Production Process Flowchart*.
4. Let us consider the main operations in making the base bottom.
5. All components, as with the lamp base, are manufactured by processes that have to take place in a definite order. The material flows from work station to work station along a planned route.
6. Just as you would use a road map in driving from New York to Los Angeles, you can use a flowchart to find what route a workpiece must take as it is

DESK LAMP PRODUCTION FLOWCHART: 12 WORK CENTERS SHOWN

This chart shows correct order of operations for Activity 81 in laboratory manual. Work centers and operations at each center are numbered. This chart is also useful for later production references.

1. SHADE TOP CENTER:

1 Shear Blanks.
2 Lay Out (Attach Pattern).
3 Center Punch For Drilling.
4 Drill Four 5/32" Holes.
5 Drill Two 1/16" Relief Holes.
6 Shear To Shape.
7 Cut Out For Flanges At Back.
8 File Burrs.
9 File All Sharp Corners.
10 Bend Sides And Flanges.
11 Bend Back.
12 Drill Two 9/64" Rivet Holes For 1/8" x 1/8" Pop Rivets.
13 Rivet Flanges To Shade Sides.
INS Inspection.
14 Store For Coating Center.

2. SHADE BOTTOM CENTER:

1 Lay Out Using Template.
2 Shear Blanks.
3 Apply Paper Patterns And Cut Notches.
4 Center Punch For Drilling.
5 Drill 9/64" Holes.
6 Drill 3/32" Holes.
7 Drill 13/32" Holes.
8 File Burrs On Edges.
9 Form In Bar Folder.
10 Remove Pattern.
11 Complete Back Bend.
INS Inspection.
12 Store For Subassembly With Hanger Brackets.

3. HANGER BRACKET CENTER:

1 Shear Blank.
2 Lay Out.
3 Trim.
4 Drill Two 9/64" Holes For Rivets.
5 Ream Holes With Awl.
6 Bend.
7 Drill Two 5/32" Bolt Holes With Drill Jig.
INS Inspection.
8 Pop-Rivet Hanger Bracket To Shade Bottom.
INS Inspection.
9 Store For Coating Center.

7. & 8. COATING CENTERS:

7 Dip Or Spray-Paint Shade Components, Stem, And Base Top.
8 Coat With Sheet Vinyl, Base Bottom.

9. ASSEMBLY CENTER:

1 Slit Cord (Slit 1-1/2".)
2 Strip 5/8" From End of Each Wire.
3 Install Socket Base To Shade Bottom.
4 Wire In Socket.
INS Inspection.
5 Install Shade Top.
6 Install 1/4" and 5/8" Rubber Grommets In Base Top.
7 Install Rotary Switch In Base Top.
8 Install Stem In Base Top (Round End First).
9 Install Cord (Top To Bottom).
10 Install Shade On Stem.

Fig. 153-1. Chart No. 153-2, Production Sequence for Activity 81

4. STEM CENTER:

1 Cut Pipe To 12" Length.
2 Squeeze One End.
3 Drill One 5/16" Hole.
4 Drill Two 5/32" Holes. (For Bracket And For Base.)
5 Bend Squeezed End To 70-Degree Angle.
6 File Burrs.
INS Inspection.
7 Store For Coating Center.

5. BASE TOP CENTER:

1 Shear Blanks.
2 Attach Paper Pattern And Cut Notches.
3 Remove Burrs.
4 Center Punch For Drilling.
5 Drill Two 13/32" Holes
6 Drill One 5/8" Hole For Stem.
7 Drill Two 3/32" Holes.
8 File Burrs Around Holes.
9 Form By Bending.
10 Remove Paper Pattern.
INS Inspection.
11 Store For Coating Center.

6. BASE BOTTOM CENTER:

1 Shear Blank.
2 Attach Pattern To Blank.
3 Shear To Shape.
4 Center Punch And Drill Three 3/16" Holes.
5 File Burrs And Sharp Corners.
6 Draw-Form Recess For Stem Screw.
7 Bend Sides On Brakes.
INS Inspection.
8 Remove Paper Template.
9 Store For Coating Center.

11 Slit Cord And Cut One Side Only.
12 Strip Wire Ends Of Cut Wire.
13 Connect Switch And Install Wire Units.
INS Inspection.
14 Knot Cord And Pull Through 1/4" Grommet.
15 Attach Stem To Base. (#6-32 FH 1/2" Machine Screw And Nut)
16 Screw Base Bottom To Base Top.
17 Install Felt Squares On Base Bottom.
18 Install Snap-On Plug.
INS Inspect And Test.
19 Label (Optional).

10. & 11. PRINTING AND PACKAGING CENTER:

1 Produce Service Manual.
2 Produce Package.
3 Produce Advertising Material. (Optional)
4 Package Product.

12. DISTRIBUTION CENTER

being processed. The first problem in your laboratory activity demonstrates the use of a flowchart to show the path of production.

7. Chart 153-1 shows the flow of processing for the entire lamp production.
8. Let us continue making our process flowchart. All the manufactured major components go to the *Coating Center*. From there the components move to the *Assembly Center*. The completed lamp is then packaged and distributed. If we needed a very detailed process flowchart, we would list all of the operations to be performed at each center as we did for the base bottom. The second laboratory activity involves the process flowchart for the *Base-Bottom Center*.
9. Now let us see how a route sheet is made. Show Transparency 153-2, *Route Sheet*. Notice that the description of operations is the same as the one used in the process flowchart. The route sheet provides additional information, such as the materials, machines, and tools required for each operation. It also shows that the operations begin at the *Fabrication Center* and end at the *Coating Center*. Problem 3 in your laboratory activity requires you to complete a route sheet.
10. If more information is needed for a worker at a particular station, an operation sheet is made up. It lists a step-by-step procedure for performing a particular operation. Show Transparency 153-3, *Operation Sheet*. Notice that this operation sheet thoroughly explains Steps 1-4 of the route sheet. You will examine an operation sheet in working out Problem 4 in your laboratory activity.
11. In summary: the *Process Flowchart* is the master plan for production, while the route sheet and the operation sheet give more specific details of the manufacturing process. Process flowcharts and route sheets list operations that involve forming, separating, or combining the product. *Operation Sheets* list detailed steps required in a process of forming, separating, or combining.

Discussion (5)

1. What name have we given to a chart that shows work centers, process operations listed in proper sequence, and the flow of parts from one work center to the next? (A process flowchart.)
2. How could you make a route sheet from information on a process flowchart? (List the operations, in order, from the flowchart and add the tools needed for each operation.)
3. How would you make an operation sheet for one of the operations listed on the route sheet? (Write the operation name and the tools needed; then describe all the steps for performing the operation.)

Laboratory Activity (20)

Today students will complete a work-center flowchart, a process flowchart, a route sheet and examine an operation sheet.

1. In Problem 1, students will draw production flow lines between production centers on Production Center Flowchart, Fig. 81-1, in the Laboratory Manual.
2. In Problem 2, students will draw the appropriate planning symbol beside each process listed on the Process Flowchart at Base-Bottom Center, Fig. 81-2 in the Laboratory Manual. Direct students to refer to the planning symbols below the chart.
3. In Problem 3, students complete a route sheet from the list of processes in the base-bottom process flowchart.
4. In Problem 4, students examine an operation sheet to mark an "X" before the main statement in the steps required to complete the process of drilling three holes in the base bottom.

Homework

Reading 75, *Establishing Production and Quality Control*

Note

If it appears that Review 9 (Optional) will be used and Alternative 3 may be covered, have students prepare these questions in advance, listing six or more words or concepts.

If Alternatives 4, 5, and 6 are to be considered, it will be necessary to make advance arrangements.

Special Instructions for Planning Production

The teacher should begin to plan in detail at this time how he will organize the production lines for the manufacture of the desk

lamp. Two different systems of production are suggested. System #1 requires very little revision of route sheets or operation sheets as presented in the Teacher's Guide. System #2 involves more advance tooling. The operation sheets and route sheets will need revision to meet the needs of System #2.

1. *System #1*
   a. The class can be divided into six groups, for fabrication.
   b. Production of one component is assigned to each group of students. Six main components are in production simultaneously.
   c. The foreman of the group decides which worker in his group should be assigned to each task or tasks listed on the route sheet.
   d. The sheet metal blanks are precut to exact length and width.
   e. The *teacher has duplicated the patterns* for sheet metal components. Students use rubber cement to cement a paper template to each sheet metal blank. (Scribing from a template could be substituted for paper patterns.)
   f. The group follows through on all operations for one component, using operation sheets as a guide for steps in some key operations, and a route teacher may want to prepare additional sheet for sequence of operations. The tional operation sheets.
   g. After components 1-6 are produced, new assignments are made. There are two coating centers, adhesive-coating and spray-painting; an assembly center; a packaging center; and a service-manual center to be manned. See Appendix F. The large, detailed flowchart and the instructions provided for each center serve to guide the flow of work.

2. *System #2*
   a. The teacher places each student at a production center or station and schedules the number of lines running each day. For example, shearing operations may be performed on all five parts at one station, on different days.
   b. Special preparation of tooling allows shearing to be done without scribing in most instances. This is accomplished by using the drilled holes in the blanks to locate the metal over pins in the shear table.
   c. Punches instead of drills may be used for the larger holes, if punches are available.
   d. Subassemblies absorb workers, as students with less time-consuming tasks complete their work each day.
   e. A process flowchart is needed to outline the merging of lines.
   f. The base bottom, stem, and base top fabrication are convenient production lines to set up first. Other students may produce the service manual and the package at the same time.
   g. The coating department operates continuously, as components are delivered.
   h. As the base bottom, base top, and stem are completed, the first groups through may be assigned to the auxiliary production. Note centers 9-1 and 9-2.
   i. When production of the first three main components is completed, instruction about the manufacture of the shade bottom, hanger bracket, and shade top may be provided. Production of auxiliary items, such as the service manual, can continue and subassembly work will be started at this time.
   j. As groups continue to complete their assigned production, final assembly groups can be formed.
   k. Production continues until the entire quantity for a particular item is completed.

3. The following points apply to both System #1 and System #2:
   a. Students are instructed briefly, group by group, how to use the equipment.
   b. An instruction panel for each production center should include step-by-step pictures, a route sheet, and operation sheets for the center.
   c. The number of workers at a work center can be written in a column on the route sheet. The route sheet can then be used to set up a production line.
   d. The route sheet can also be used effectively to schedule the number of different operations and components in process at a given time. Several components have to be in progress at

one time, to prevent production delays.

e. The groups proceed to perform production operations, as assigned, until production is completed.
f. The electrical wiring needs special supervision and inspection. The most dependable boys in the class should be assigned to this work.
g. As individuals and groups complete components, they can be assigned subassembly and assembly work.
h. Production control may require careful planning, particularly in assembly work.

4. The teacher must cut out one metal shade-top go-no-go gage and one base-bottom go-no-go gage for each group of five students in Assignment 154.

   Figures 154-2 and 154-3 provide patterns for the gages.

   The teacher may decide to duplicate the patterns and have each student make a gage.

Note

See also Teacher's Guide Assignments 157-168 for further equipment needs and suggestions. Chart 153-2, Production Sequence for ACTIVITY 81, Fig. 153-1, shows the complete array of lamp production processes.

ASSIGNMENT 154, ACTIVITY 82
READING 75

Establishing Production and Quality Control

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on establishing production and quality control:
   a. Describe what differences there are in the quality control of a $.10 pen as compared to a $3.00 pen.
   b. Name some of the production control problems that a large clothing manufacturer might have.

Discussion

2. Given a presentation-demonstration and a transparency:
   a. Name three controls needed in production control.
   b. State the purpose of inventory control.
   c. Name two means of providing quality control.

Laboratory Activity

3. Given components, gages, and inspection templates:
   a. Inspect two flat base-bottoms and two shade-top components and, by using an inspection template, distinguish between the reject and the acceptable components.
   b. Inspect two formed base-bottoms and two formed shade-top components and, by using a go-no-go gage, detect the reject and the acceptable components.

Time Schedule

5 Overview
15 Presentation-Demonstration
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

Equipment

1 overhead projector/screen
1 shade-top go-no-go gage No. 154-2
1 base-bottom go-no-go gage No. 154-3

Supplies

1 flat lamp base-bottom
1 flat lamp shade-top
1 complete lamp to break down into three major subassemblies

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1 lamp base bottom flat metal inspection template
1 shade-top flat metal inspection template
1 go-no-go gage to inspect formed shade tops, Fig. 154-2
1 go-no-go gage to inspect formed base bottom, Fig. 154-3

Supplies (Group of 5)

1 acceptable flat base-bottom component
1 defective flat base-bottom component
1 acceptable flat shade-top component
1 defective flat shade-top component
1 acceptable formed base-bottom component
1 defective formed base-bottom component
1 acceptable formed shade-top component
1 defective formed shade-top component

Note

Components used in the activity are retained from the demonstration of prototype in Assignment 149-151.

Overview (5)

1. In our last lesson we reviewed some uses of process flowcharts, route sheets and operation sheets.
2. Today we will study some practices in production control and quality control and outline plans for establishing production control and quality control in the lamp production.
   a. Production control was practiced during manufacturing of each of our main products.
   b. We wrote operation sheets, made process flowcharts, monitored production, reported, and corrected malfunctions in the system.
   c. We practiced quality control by inspecting each of the products.
3. Production is controlled by production planning; scheduling of materials, workers, and machines for production; issuing a bill of materials; dispatching work orders; monitoring; and correcting.
4. Production control also includes inventory control to assure that all materials needed in production are at the *right place* at the *right time* for a steady flow of production.
5. You will be asked to name three ways in which *production* is controlled.
6. I will also ask you to name three ways in which *quality* is controlled.
7. In your laboratory activity you will *inspect* lamp components as you will be expected to do during production.

Presentation - Demonstration (15)

Production control and quality control must be practiced in any mass-production situation to obtain a quality product in the right quantity.

1. Production control includes *scheduling of work* to be done at just the right time, and for the right length of time, needed to fill orders for customers. *Route sheets* must be made to show the flow of production through work centers for the forming, separating, and combining processes so that they will occur in proper order.
2. *Inventory control* is also a part of production control. This is to insure that materials, parts, and assemblies are delivered as needed and accounted for in records.
3. We will practice scheduling of work to be done at the right time, and for the right length of time, when we mass-produce the lamp. We will use route sheets and process flowcharts to direct the flow of production in the correct order through work centers.

   Teacher: Point to the lamp Production Center Flowchart on the wall and name some of the processes to be done at each center.
4. We will practice *inventory control* (a) by accounting for the units of lamp com-

Production Center Inventory Control Student	Base Bottom Blanks		Base Bottom Vinyl Coat		Socket and Wire		Stem-Base-Top Grommets-Switch	
	Units Start	Complete	Units Start	Complete	Units Start	Complete	Units Start	Complete
Period 1 1. Jim Jones	20	20						
2. Tom Bell			20	20				
3. Jeff Bohn					10	8+2		
4. Todd Dale							25	25
Period 2 5. Curt Walters	18	18						
6. Howard Davis			15	15				
7. Dick Johnson					10			

NOTE TO INVENTORY CONTROL STUDENT: You may deliver parts for each subassembly as a unit in a paper bag to workers in your center. The number of completed units should be recorded on the inventory control chart.

Fig. 154-1. Inventory Control Chart

ponents and subassemblies delivered *to* workers and (b) by accounting for the completed work units received *from* the workers. The inventory control system we will discuss is just one of many we might use. Let us examine an inventory control chart. See **Fig. 154-1**, Inventory Control Chart. This example is to be explained as related to **Fig. 83A-P-3** in the Laboratory Manual.

a. Tom Smith is the group foreman serving as the inventory control specialist. He delivered 20 base-bottom forms and 20 vinyl covers to the workers in his production center.
b. Tom recorded as "complete" 20 base bottoms with vinyl coating adhered when the work was completed.
c. Roy Brown delivered to his group 10 paper bags each containing the components and subassemblies needed to make 10 socket and wire subassemblies.
d. Roy returned eight socket and wire subassemblies and two bags of unassembled parts to the inventory control center at the front of the room. His group was unable to complete all units.
e. A total for one day's production in all classes could be found by totaling each "complete" column.
f. The workers in charge of the inventory control center must examine contents of the bags of supplies charged out and units of completed work returned to be sure that all parts are accounted for and ready for the next step of production. They must also keep an accurate record on the Inventory Control Chart.

Teacher: Display the completed subassemblies ready for final assembly. These subassemblies may be obtained from a completed lamp.

5. Quality control means inspecting and testing to see that components, subassemblies and completed lamps are made according to previously established plans or specifications. Efficient production tools also help to control quality.
   a. We will use inspection templates and different kinds of gages to accurately *inspect* the product so that errors can be *reported* and corrected.

Teacher: Display a metal base-bottom template.

   b. The use of special tools like jigs and fixtures in manufacturing the product also helps to control quality. We will use drill fixtures.
   c. There are four things we inspect in fabricated products: size, shape, position relationship, and function.
   d. You may recall something about the terms bilateral tolerance, unilateral tolerance, clearance, and interchangeability of parts.
   e. *Unilateral tolerance* of the base top could mean that we might tolerate the

314

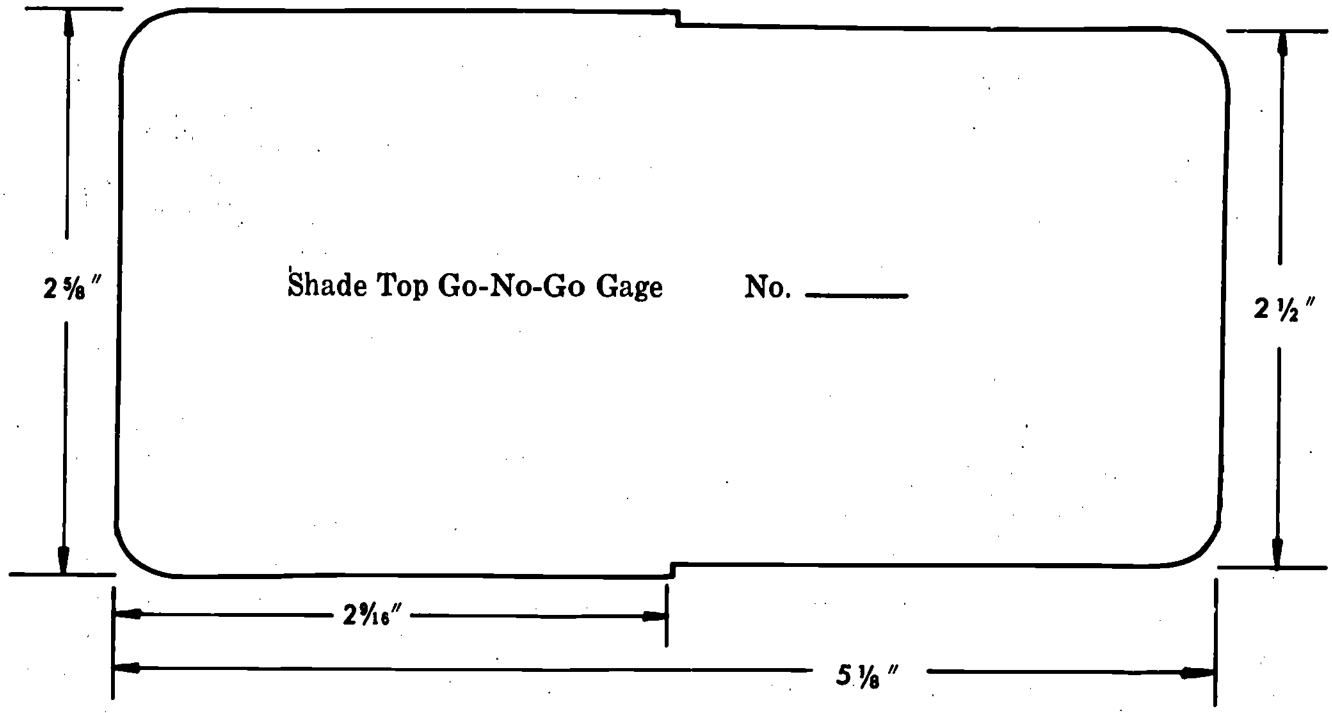


Fig. 154-2. Shade Top Go-No-Go Gage (Full Scale)

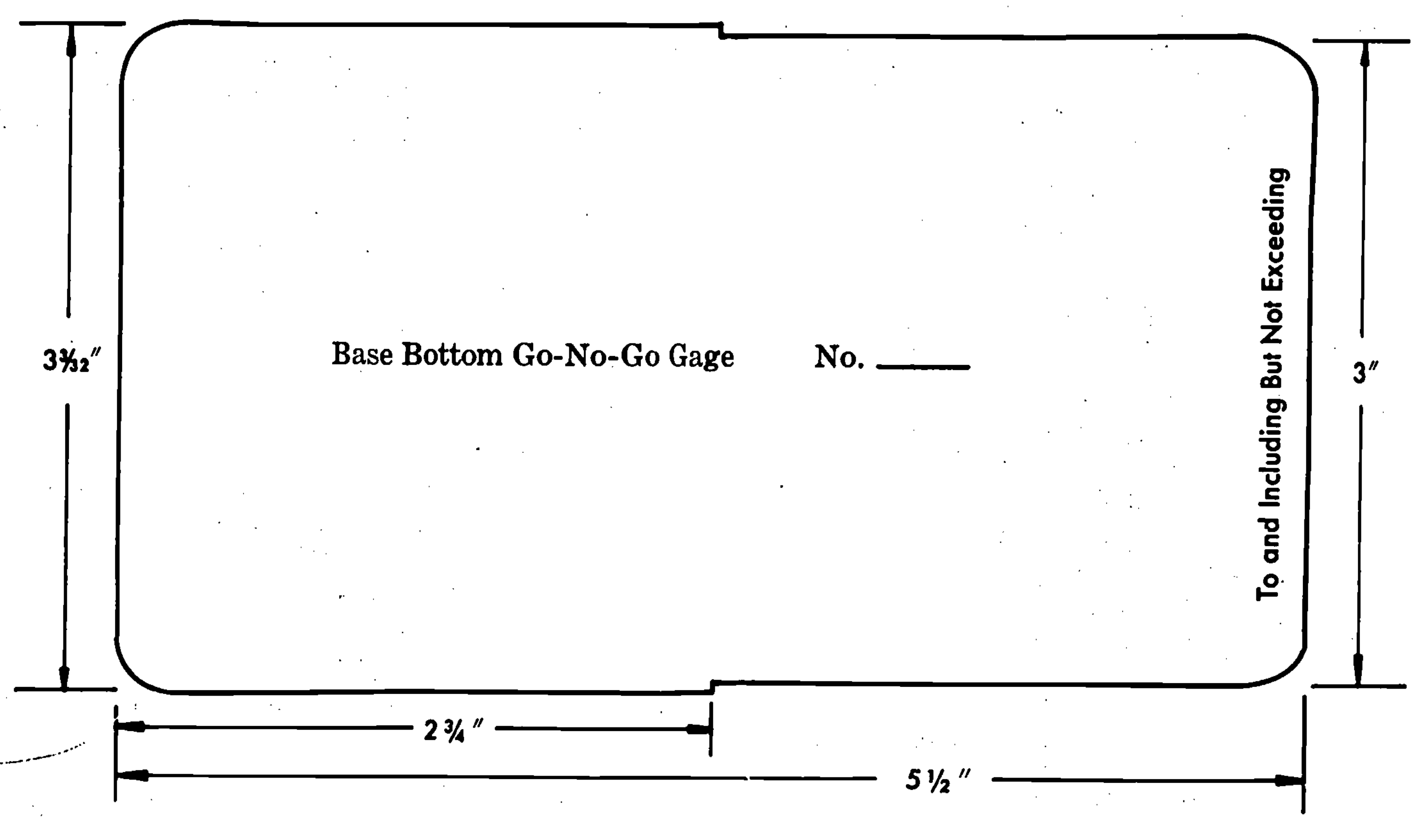


Fig. 154-3. Base Bottom Go-No-Go Gage (Full Scale)

base top being as much as 3/32″ narrower than the base bottom, but the base top could never be equal to or wider than the base bottom. Unilateral tolerance could go in one direction only.

Teacher: Demonstrate positioning the base top in a base bottom.

f. *Bilateral* tolerance could mean that the lamp cord could be 1″ longer or 1″ shorter than the specified length.
g. Inspection for *clearance* could mean that the bolt-hole in the stem should be large enough to allow the bolt to fit loosely.
h. Inspection for *interchangeability of parts* would mean that any base top

must fit all base bottoms to be acceptable.

i. During the lamp production, we will have an inspector at each production center and one at the inventory control center to double check quality. Each final-assembly inspector will sign his name to an inspection tag tied to each major assembly to certify his responsibility for passing the assembly.

6. Demonstrate briefly the use of the inspection templates and the go-no-go gages.

Discussion (5)

Guide the discussion so that the following points are reinforced.

1. Name three controls that are needed in production control:
   a. Schedules of work to be done.
   b. Route sheets.
   c. Inventory control.
   d. Order control is a possible answer.
2. What is the purpose of *inventory control*? (To assure that parts are available as needed and accounted for in records.)

Possible Quality Control Gages

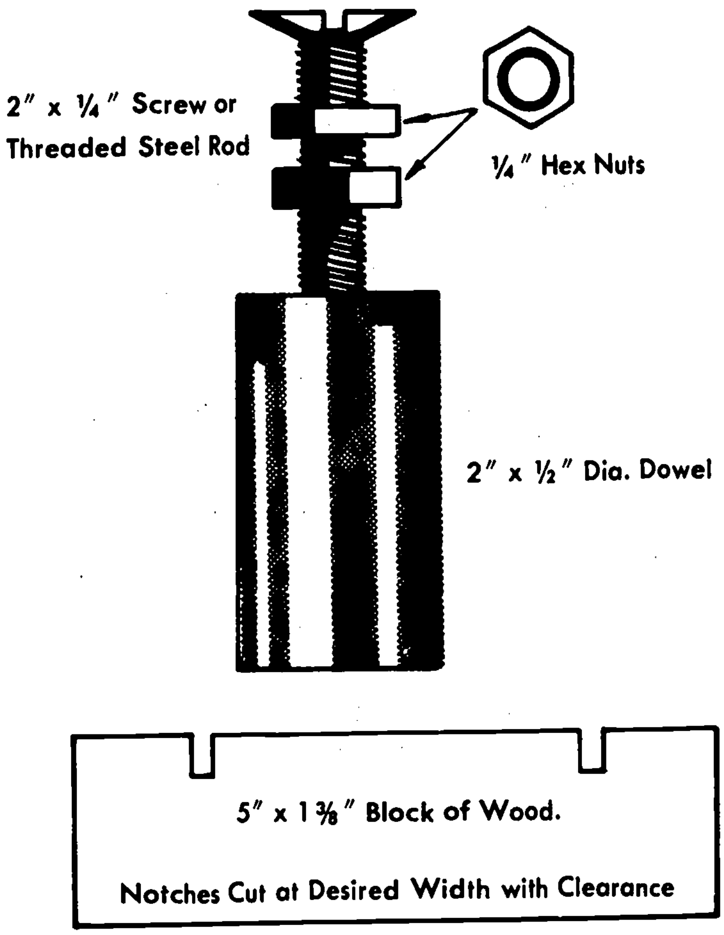


Fig. 154-4. Quality Control Devices

3. How is *quality control* provided? (Through inspections, tests, and the use of templates, jigs, and fixtures.)
4. In what way does the use of *jigs* and *fixtures* aid in quality control? (By reducing the chance of error in the production of a part.)

Laboratory Activity (20)

Today each student will use inspection *templates* and inspection *gages* to inspect lamp components and record his decision in each case.

1. Each student will use a base-bottom inspection template to inspect drilled and sheared flat base-bottom components.
2. Each student will use a shade-top inspection template to inspect drilled and sheared flat shade-top components and record his decision.
3. Each student will use a go-no-go gage to inspect the width of two formed base bottoms.
4. Each student will use a go-no-go gage to inspect the width of two formed shade tops.

Note

Components used in the activity are retained from the prototype, Assignments 149-151. All components should be numbered consecutively for students to record each inspected component.

5. The work area for each group of five students should be supplied with one acceptable and one defective of each of the components to be inspected. One each of the go-no-go gages and one each of the inspection templates must be provided at the work area for each group of five students.
6. The teacher must cut out one metal shade top go-no-go gage and one base-bottom go-no-go gage for each group of five students. See Figs. 154-2 and 154-3. The teacher may decide to duplicate the patterns and have each student make a gage.
7. Examples of quality control gages that the teacher could develop for his personal use, or to be used by a group foreman, are illustrated in Fig. 157-4.

Homework

If the Optional Assignment 155 is used, have students review readings 66-75. If Assignment 155 is not used, there is no homework.

ASSIGNMENT 155 (OPTIONAL)

Review No. 9

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

Given the summaries of Readings **66-75**, ask and answer questions about printed products, the manufacturing corporation, forming a corporation, locating a plant and securing inputs, relating people to a corporation, designing and engineering the product, making a sales forecast, estimating profits, keeping records, planning production processes, and establishing production and quality control.

Time Schedule

45 Discussion or Laboratory Activity

Discussion or Laboratory Activity (45)

This review time can be used in various ways. Plan to do one of the following alternatives.

Alternatives

1. Students can play the "Big Manufacturer" game to become more familiar with the concepts and processes of manufacturing.
2. Pose the questions and situations at the end of each reading to stimulate thinking and discussion.
3. Have each group of students get together and select from their lists two or three words of concepts they would like to have explained or discussed. Discuss and clarify the concepts.
4. Ask a guest speaker who is knowledgeable about setting up a corporation or planning production to talk to the class. Schedule the speaker for the first class period and tape record his talk since it can be played to your other classes.
5. Schedule a field trip to a manufacturing corporation.
6. Present a film showing some of the concepts the students have discussed.

Homework

None

Test No. 9

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given IACP Manufacturing Test No. 9, select the correct responses from a list of items related to concepts presented in Readings 66-75.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

This is a suggested outline of steps. It may vary according to circumstances.

1. Seat the students to best advantage for administering the test.
2. Distribute pencils, erasers, etc.
3. Place the test and answer sheet upside down on each student's desk.
4. At your command, have students turn over the tests and answer sheets.
5. Follow directions as given with the test.
6. Allow 35 minutes for completion; then collect test papers.
7. Review the test with students.

Homework

Reading 76, *Making and Combining Components and Assemblies*

Note

Have your instruction panels for each center ready for the next class. Have signs to hang up over each center such as, "PAINTING CENTER," etc. Use magic marker on cardboard and hang signs on a coat hanger suspended from a pipe or light fixture, etc.

Centers are vital in the next classes. Consider them before beginning.

Answers to Test No. 9

1. D	2. B	3. D	4. C	5. B	6. A	7. A	8. C	9. D
10. B	11. C	12. B	13. A	14. C	15. B	16. C	17. C	18. A
19. B	20. C	21. A	22. D	23. A	24. D	25. C	26. B	27. D
28. A	29. B	30. C	31. A	32. C	33. D	34. B	35. A	

ASSIGNMENTS 157-174,
ACTIVITY 83-A-P
(K and P OPTIONAL)
READING 76

Making and Combining Components and Subassemblies

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about making and combining components:
   a. Look at a table lamp and identify what separating, forming and assembling processes were used on the shade top, body, and electrical circuit.
   b. Name some of the problems the manufacturer of a supersonic commercial passenger airplane must solve in *assembling* the different parts and subassemblies.

Laboratory Activity

2. Given the necessary equipment and supplies, make enough components so that when they are combined there will be a completed lamp for each student in the corporation.
3. Given the necessary tools, manufactured and purchased components, combine them so each student in the corporation receives a complete and tested lamp.

Time Schedule

Assignment 157

5 Overview
5 Presentation
5 Discussion
30 Laboratory Activity

Assignments 158-162, 164-168, 170-174

Overview — A recap of the progress should be made at the beginning of each assignment.

Demonstrations — should be incorporated as needed.

Laboratory Activities — will take most of the time during these assignments.

Equipment for Laboratory Activities 89 A-P

All Phases

Equipment (Class)

1	overhead projector w/screen
2	scribers *or* scratch awls
1 pr.	wire cutters
5 pr.	scissors
2	pop rivet guns
2	ball peen hammers
1	center punch
2 pr.	wire strippers
1	squaring shear, 24-inch or larger
5 pr.	combination tin-snips
2	utility knives
1	drill press
3	hand drills
1	3/8" electric drill
1	3/32" twist drill
1	1/8" twist drill
1	5/32" twist drill
1	5/16" twist drill
1	9/64" twist drill
1	13/32" twist drill
1	5/8" twist drill, with 1/2" shank
1	3/16" twist drill
1	tape writer, optional
1	box and pan brake for bending sheet metal
1 pr.	slip-joint pliers
2	24" rules
8	bench vises
4	4" C-clamps
1	hacksaw w/blade, 32 points/inch
1	flat mill file
1	round file
6	standard screwdrivers
1	No. 5 metal punch
1	hand notcher, 90°

Equipment — Package (Class)

1	bench rule
1	squaring shear
1	screen-stencil frame and stencil
1	utility knife
1	rubber squeegee
1	template for top
1	template for bottom
1	tape-cutting jig
2	wooden blocks

313

Equipment — Spray Painting (Class)

2 spray booths, cardboard boxes
1 pc. 12" x 12" approx., peg board 1/4" dia. holes or scrap plywood
1 jar liquid rubberized vinyl, optional

Equipment — Vinyl Coating (Class)

1 24" rule
1 scratch awl
1 pr. scissors

Equipment — Service Manual (Class)

1 12" rule
1 spirit duplicator
1 X-acto® knife
1 stapler
1 paper cutter
1 screen-stencil frame
1 rubber squeegee
Several service manuals for various products

Supplies for Laboratory Activities 93 A-P

Supplies (Class)

1 Transparency 148, *Exploded View and Lamp Parts List*

		Part No.
3 shts.	(or 36 sq. ft.) 24" x 72" 26- or 28-gage black iron	6
1 sht.	(or 12 sq. ft.) 24" x 96" 20- or 22-gage galvanized steel or black iron, for base bottom	1, 2, 3, 5
4 pcs.	1/2" O.D. x 10' 0" aluminum tubing	14
180 ft.	No. 18-2 brown lamp cord	8
25	brown snap-on electrical plugs	9
50	No. 72B wire nuts (small)	10
25	6-A, 125V canopy switches, rotary, single pole	7
25	75W, 250V sockets, base for high-intensity bulb	12
25	40W, 120V bulbs, high intensity	11
25	1/2" rubber grommets, 1/2" I.D., 5/8" O.D.	15
25	1/4" rubber grommets, 1/4" I.D., 13/32" O.D.	14
25	1/8" x 3/4" long pipe nipples, with hex nuts	13
25	steel washers for No. 6-32 machine screws	18
100	1/8" x 1/8" pop rivets	20
25	No. 6-32 x 1/2" FH machine screws with hex nuts	19
25	No. 6-32 x 3/4" RH machine screws with wing nuts	17
150	No. 6 x 1/4" pan head sheet metal screws	16
1/2	sq. yd. adhesive-backed felt	21
15 ft.	18" wide wood-grain contact vinyl *or* other pattern	22
1 sht.	medium-grit emery cloth	
1 roll	embossing tape, optional	
1 gal.	rubber cement	
1 qt.	rubber cement thinner	

Supplies — Package (Class)

1 jar screen-stencil paint
40 ft. masking tape *or* gummed paper tape, 2" wide
15 shts. .030-gage, 28" x 44" chipboard

Supplies — Spray Painting (Class)

1 box paper clips
1 pkg. steel wool
1 qt. vinegar, 5% acidity
clean rags
2 13 oz. aerosol cans, brown paint
6 13 oz. aerosol cans, white paint *or*
1 gal. white fast-dry enamel
1 gal. brown fast-dry enamel

Supplies — Service Manual (Class)

50 shts. duplicator paper
12 shts. plain paper, for sketching
2 spirit masters
1 pc. self-adhesive plastic stencil film
1 jar screen-stencil ink
20 shts. colored construction paper, 5 1/2" x 8 1/2"
6 shts. tracing paper

Overview (5)

1. We have been planning production processes and you were involved in making the prototype. For the next three weeks we will be producing and assembling components to make the product and arrange for sales and distribution.
2. Your text reading described various industrial processes involved in manufacturing the lamp.
3. I will outline for you the activities involved in the desk-lamp manufacturing process.
4. I will ask you to identify separating, forming, and combining operations involved in the manufacture of the lamp.
5. We will establish production centers and assign personnel to the jobs at each center.
6. Later, I will demonstrate to you the step-

by-step procedure of assembling the high-intensity lamp.

7. When the time comes, we will establish assembly centers, assign personnel to each center, and begin assembly of the lamp.

Presentation (5)

For the next three weeks you will be manufacturing desk lamps.

1. Your jobs will be *specialized.* Specialization in skills means a worker limits the type of work he does to just a few tasks. Workers in industry must be *specialists* to produce efficiently.
2. As a member of the work force producing the desk lamp, you will work on only certain components of the lamp. Other members of the work force will work on other components.
3. *Quality control* will be important in this activity, so that all the parts will fit together and the lamp will function.
4. The manufactured product (the lamp) will be mass-produced as a class activity. Some component parts will be fabricated; others will be purchased. The components will be assembled to make a completed lamp.
5. A service manual will be written and printed.
6. A box in which to package each lamp will be manufactured.
7. Show Transparency 148, *Exploded View and Lamp Parts List,* with overlays to students when you are giving the demonstration on assembling the components.
8. At the completion of this activity, enough lamps should have been manufactured so that there will be one for each member of the corporation.

Discussion (5)

Let us discuss some of the different manufacturing processes we will use during the next few days.

1. Give an example of each of the following operations in the production of the lamp:
   a. Separating, shearing blanks.
   b. Forming, bending the stem.
   c. Combining, pop-riveting the shade.
   d. Final assembly, assembly base, stem and shade.
   e. Coating, painting and application of vinyl.

Laboratory Activity (30), Assignment 157

1. The teacher should refer to Teacher's Guide Assignment 153, Planning Production Processes, for detailed outlines of class organization in production of the lamp. The Production Process Flowchart specified the various production centers.
2. *Each group must have an Instruction Panel consisting of step-by-step pictures of the operations to be completed by the group, a route sheet, and an operation sheet where needed.*
3. The route sheet lists the tools needed for the operations and outlines the operations in the order that must be followed in the manufacturing of the components.
4. The Production Process Flowchart outlines production centers and the flow of production for the entire manufacturing process. Check this chart to see where each group may be assigned to succeeding steps in production, as the beginning phases are completed. *Display this chart until the lamp is completed.* Relate this chart to the instruction panel.
5. It is suggested that you have cardboard boxes for four kinds of operations: separating, forming, combining into subassemblies, and assembling the product. A separate set of boxes should be provided for each class section, labeled plainly. Instruct the students to place their work in these boxes at the end of each period.
6. Optional additional activities are making advertisement posters and signs, writing slogans, and preparing scripts for radio and television commercials. These activities may be done throughout the industrial arts section or, preferably, throughout the school. If scripts are prepared, it may be possible to tape and play them to classes.
7. If you find it impossible to find work assignments for all students in the fabrication of components or the assembly of components, the teacher may elect to let the unemployed students play the "Big Manufacturer" game until work assignments are available. This may be connected to procedures related to filing for unemployment benefits. (This may require the collection of a file of forms from a local agency.) The concept of being "layed off" may also be discussed.

Laboratory Activity, an Alternate Fabrication Organization

1. Make assignments, explain duties, and answer questions.
2. Explain that each production center group of students must have a *foreman*, a *recorder*, an *equipment supervisor*, a *timekeeper*, and a *safety supervisor* as part of their production center organization.
3. Check to be sure that each recorder lists on Fig. 83A-P-1, Production Center Assignments Chart, all personnel for his group.
4. Explain to students their special duties.

Special Duties

1. Foreman's duties:
   a. The *foreman* for the group at each Production Center will be responsible for obtaining and returning the Instruction Panel each day.
   b. The foreman must also check to see that each student in his center is satisfactorily performing his assigned work.
   c. Any work not satisfactorily done must be reported to the teacher. This includes checking special duties, such as cleanup and return of special tools.
2. Recorder's duties:
   a. The *recorder* will maintain the Production Center Assignment Chart. The chart must show each student's center and operation number, and briefly describe his job.
   b. The recorder will fill out the chart as soon as assignments are made, remove the assignment chart, Fig. 83A-P-1, from the Laboratory Manual, and place the chart in a labeled folder at the front of the room for both student and teacher reference. The teacher may choose to duplicate the chart and give the recorder a copy.
   c. *Keep this chart up to date* with any changes of assignment or work performed.
   d. The recorder will also check daily the Student Work Report Chart, Fig. 83A-P-2, in each Laboratory Manual in his group.
3. The *equipment supervisor* will obtain and return all special tools, jigs, and fixtures each day.
4. The *timekeeper* will report anyone not starting his assigned duties or work on time.
5. Safety supervisor's duties:
   a. The *safety supervisor* will report to the teacher any unsafe conditions with tools or machines.
   b. Report to the teacher any dangerous conditions caused by students, such as not wearing safety glasses, or the misuse of tools and machines.

Material Control

6. It is suggested that the teacher bag, box, or tie together kits of supplies for each station in each class. Have this done before class. Assign a responsible student as *material control man* to dispense materials at the necessary points and to return containers of finished parts at the end of the period. See Fig. 154-1. Show students how to fill out the Inventory Control Chart (Laboratory Manual Fig. 83A-P-3).
7. *All students* are individually responsible for cleanup in their area.
8. During the last five minutes of the laboratory activity today, each student should fill out the Student Work Report Chart in the Laboratory Manual. Instruct students that information about the kind of work they did and how much work they did must be entered in their Laboratory Manual each day. (The group recorder will check each day to see that this task is completed.)

Service Manual

1. The service manual will be produced in the same manner as the autograph booklet in Assignment 140. If a spirit duplicator is not available, the manual can be printed on hectograph.
2. From one Laboratory Manual the teacher should remove Fig. 78B-3, exploded view of the lamp. Make a heat spirit master for use by each class. An alternative method is to have a student trace it onto a spirit master. This becomes the center fold of the service manual.
3. The teacher should have sample warranties and service manuals available for students to study.
4. Save the screen stencil. It is to be used in production center 9-3 to print the same design on box tops.

Assignment Schedule for Next 17 Days

Assignment	Activity	
158	87B	Making and Combining Components and Subassemblies
159	87C	Making and Combining Components and Subassemblies
160	87D	Making and Combining Components and Subassemblies
161	87E	Making and Combining Components and Subassemblies
162	87F	Making and Combining Components and Subassemblies
163	88	Establishing Quality Control Systems
164	87G	Making and Combining Components and Subassemblies
165	87H	Making and Combining Components and Subassemblies
166	87I	Making and Combining Components and Subassemblies
167	87J	Making and Combining Components and Subassemblies
168	87K	Making and Combining Components and Subassemblies
169	89	Arranging for Distribution and Sales
170	87L	Making and Combining Components and Subassemblies
171	87M	Making and Combining Components and Subassemblies
172	87N	Making and Combining Components and Subassemblies
173	87O	Making and Combining Components and Subassemblies
174	87P	Making and Combining Components and Subassemblies

Package

1. Students will need two templates and a tape-cutting jig, to fabricate the package. See Fig. 169-1 at the end of Assignment 169 in the Teacher's Guide.
2. To cut chipboard, scissors or other hand-cutting tools may be substituted for utility knives.

Note

During each production day the teacher will again need to take notes so that new job assignments can be made for the remaining production days.

Homework

At the end of Assignment 162, assign Reading 75, *Establishing Production and Quality Control Systems.*

At the end of Assignment 168, assign Reading 79, *Arranging for Distribution and Sales.*

Note

The following suggestions to the teacher are important to read and consider.

Suggestions on Fabrication Practices

The fabrication of the lamp components is probably the most important phase in making the lamp. *Organization* is the *most important thing* to remember at this point.

The *scheduling* of workers to fabricate the components will be very important. The individual situation will have to be considered giving attention to the available space, tools and equipment. Each day the teacher will have to make assignments which will involve all students in some activity in the fabrication of the components as outlined on the *instruction panels* or in one of the associated centers.

It was suggested, during the assignments on making the *prototype,* that you *train students* for the different work stations on one component. The Teacher's Guide suggests that each component be made by a group as in the production of the prototype. The *route sheet* on the *instruction panel* will show the step-by-step procedures used. It is also possible to arrange one or more production lines using the operation sheets and route sheets as a guide. One or more students may be assigned to each operation depending upon the manpower needs and time requirements of each operation. If this procedure is selected, the *coating centers* should also be organized to prevent a delay in assembling the components in a later assignment. Refer to the *Production Process Flowchart* to help you organize the fabrication and coating of com-

ponents regardless of the organization employed. This will aid in a smooth operation and keep the *maximum number* of students employed. Keep in mind that the *service manual,* including instructions, warranty, a parts list, and the *package* used for distribution, must be finished at the same time or before the lamp is completed.

You may want to shear a few of the blank components before fabrication begins so students can perform this operation, but there will be enough components so that drilling and shaping operations may begin promptly.

From the very beginning you should stress *quality control.* There are some suggestions for quality control *fixtures* given in Assignment 145. Each inspector should be equipped with some device to check the quality of each component. It is essential that the components are the proper size and folded along the lines of the paper template, so that when they are joined to another component they fit properly.

Inventory control should be practiced by having the final inspector keep a record of the number of components produced which are acceptable and the number which were rejected. Further suggestions will be given preceding the assignments on assembling components.

Before starting the *coating center* the teacher should *give* a *demonstration* of the correct procedures, since this was not included during the production of the prototype.

Mount and *display* the *instruction panels* in the areas where the activities illustrated occur. Local conditions will determine the best way to accomplish this.

The teacher should make note of any production procedures that he believes should be changed on the following days. These needed changes may be discussed in the overview the following day.

Procedures for Fabricating Components

1. The patterns or templates are numbered 1 to 6 with the shade top being number one and the base bottom being number six.
2. Because the shade bottom No. 2 and the hanger bracket No. 3 are the first used in assembly, it is suggested that you fabricate and assemble this subassembly first. It is further suggested that you make the stem and shade top components next.
3. Because the shade top is so important to appearance, this component must be fabricated with the utmost care. It is suggested that some of the best students be assigned to the fabrication and forming of this component.
4. Paper templates must be cut very neatly. The object lines must be left on the paper template. Then, care must be taken to apply the template to the blank evenly. The teacher should have an ample supply of these paper templates.
5. In addition, two metal templates of each sheet metal component may be made. They should be accurate in every detail, with $1/16''$ holes drilled to indicate the exact center of all holes to be drilled in the components. The metal template should be clearly marked "Template" on both sides with a magic marker. A component, or a number of components, may be placed in a drilling fixture and then the template is placed on the top component. Using a punch, locate the center of all holes to be drilled by punching through the template. Caution: *Remove the template before drilling.* The second template you made should be kept in reserve to replace any damaged templates.
6. Students should wear goggles when drilling. They should check to see that the components are securely clamped when drilling. The fixtures may be used to gang-drill 10 or more components, or to drill them one at a time. Punch holes if equipment is available.
7. If a box and pan break is not available, bending fixtures may be made of hard wood for 26 gage or lighter metal.
8. It is suggested that the teacher have each class make two or three additional lamps. The better ones may be given to the principal or other key people who have helped the teacher. If any student who worked very hard failed to get a good quality lamp, the teacher might want to "swap" with the student. Do not distribute lamps until Assignment 175, ACTIVITY 86.
9. If students desire to do so and the materials are available, the teacher may choose to permit students to apply contact vinyl to the lamp stem. Caution: While it is permissible to have different color com-

binations, too many colors in the laboratory will cause numerous problems.

An Alternate Fabrication Organization

1. Obtain the route sheet for the component you have chosen. It is suggested that you start with shade bottom or hanger bracket. It is suggested the stem be third.
2. Before class begins, arrange the portable equipment in a line in the laboratory as outlined in the route sheet.
3. Assign the number of students needed to perform the operation at each station according to difficulty of the operation and time requirement. After fabrication begins, you may see a bottleneck develop and need to make some changes in assignments to produce a smooth flow along the line.
4. Inspection should be assigned after critical operations.
5. After the component has been completed, it should be sent to the paint center before it is stored.
6. If not all the students are employed in fabrication or coating, the balance may be assigned to cutting the wire to lengths, cutting the contact vinyl to the blank size, working on the service manual and the package.
7. The following day the teacher may reassign students to work on another production process on another component. If this is done, the teacher should explain that industry would not do this but that we are doing it so each student has the opportunity to become experienced in many operations. Reassignments may be repeated until all components have been fabricated and coated. The large Production Process Flowchart will be very helpful in planning the following activities.
8. After all components are fabricated, pass inspection, and are coated, you are ready to plan assembly of the components to produce a complete lamp with the service manual and its package.

Shade Assembly Center

Number of Students	Job Description
1	Mount socket base to shade bottom. Split cord 1½″.
1	Strip ⅝″ from end of each wire.
3	Attach wire to socket.
1	Assemble socket to socket base and test, INSPECTION. Test screw in bulb, attach plug, plug in wall outlet.
2	Assemble shade top to shade bottom.

Base Top Center

Number of Students	Job Description
1	Install switch to base top.
1	Install ¼″ I.D. and ½″ I.D. rubber grommet.

Stem Center

Number of Students	Job Description
1	Install stem in base top.
1	Install cord in stem.
1	Install shade on stem.
1	Split cord and cut one side only.
2	Connect switch and install wire nuts.
1	Attach plug and check switch, INSPECTION.
1	Knot cord and pull through grommet.

Base Bottom Center

Number of Students	Job Description
2	Attach stem to base bottom.
2	Screw base bottom to base top
2	Install square pads on base bottom and make and install name plates. Model No. and Serial No.
1	Install snap-on plug and inspect.

Suggested Organization for Assembly

There are several ways of setting up the assembly centers for the lamp. The following has been drawn up for your convenience as a possible way to set up your assembly line.

The suggested list includes work for 25 students, although more students could be used. The teacher must decide if this procedure will fit his situation. This is only a suggestion and may be changed in many ways.

ASSIGNMENT 163, ACTIVITY 84
REVIEW READING 75

Establishing Production and Quality Control

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given a presentation-demonstration:
   a. Name three things that can be done to control production.
   b. Name two examples of interchangeability of parts in lamp production.
   c. Name the practice that controls the quality of our lamp.

Laboratory Activity

2. Given the necessary reassignment to jobs, continue production of the lamp.

Time Schedule

5 Overview
10 Presentation-Demonstration
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Presentation - Demonstration

Supplies (Optional)

samples of components and assemblies that require special inspection procedures

Overview (5)

We will review our experiences in production and quality control.

1. Our first lesson in establishing production and quality control covered practices in production planning, inventory control, and inspection.
2. Today we will examine in detail some of our experiences in maintaining a flow of quality components and assemblies in production.
3. I will expect you to be able to tell me how we keep track of the number of parts in production and how we check these parts to be sure they are made right.

Presentation - Demonstration (10)

1. Production control consists of a number of things we do to see that production will take place in an efficient way and at the right time. To accomplish this purpose we must:
   a. Plan production by making route sheets and operation sheets.
   b. Schedule workers to start and complete work at a given time.
   c. Deliver materials and parts to the right place at the right time.
2. Quality control, which we practice as inspection of parts, also controls pro-

duction by monitoring, reporting, and insisting on correction of unsatisfactory parts.

3. The teacher should at this time review the production control practices being used in lamp production.

Quality Control

4. We know by this time that all parts that are to be assembled must be *interchangeable*. The teacher should demonstrate interchangeability of lamp parts with various components.
5. To be *interchangeable*, components must be made to within a close range of the exact size we would like. This range of variation in size of the parts is called *tolerance*. The teacher can use the go-no-go gages to demonstrate tolerance.
6. We *inspect* parts to see if they are within the specified tolerance.
7. If we inspect only a few parts among all the parts going through production, we call the inspection *random* sampling. Random sampling is used when there is a large number of parts to be inspected, and it is impossible to inspect each individual part. To insure accuracy, it is necessary to inspect every third or fourth (depending on the quantity) piece coming through the production line.
8. Most of the inspecting we are doing must be done on every part. The teacher should enumerate critical points for inspection.
9. We do no testing that would damage the lamp. If inspection required a random sampling to see if the average lamp could be dropped a minimum of ten times before it would break, this would be called *destructive* testing.
10. The teacher should at this point discuss needed improvement in lamp production control and quality control. Demonstration of correct procedures may be necessary.

Discussion (5)

Guide the discussion to encourage students to examine the production control and quality control activities in the lamp production.

1. Name three things that can be done to control production. (Make route sheets and operation sheets. Assign workers to jobs and schedule production. Deliver parts and assemblies when they are needed.)
2. Name two examples of interchangeability of components that we manufacture. (All of the components must be interchangeable. Answers vary.)
3. What is the name of the practice that allows us to be sure that the lamp is being made right? (Inspection.)

Laboratory Activity (25)

The remainder of the period may be used for continued lamp production or for discussion and making job assignments for the next day.

Safety Precautions

1. Wear safety goggles in the work areas.
2. Follow the safety precautions outlined by the teacher.

Homework

None

Note

Plan student work organization for final assembly of the lamp.

Answers for Laboratory Manual

1. Production control
2. Inspection
3. No
4. Tolerance
5. Destructive testing

ASSIGNMENT 169, ACTIVITY 85
READING 77

Arranging for Distribution and Sales

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about arranging for distribution and sales:
   a. Look at a package and describe how it contains, identifies, protects, and displays the product.
   b. List as many places as you can think of in which you would advertise your desk lamp to reach as many teenagers as possible.

Discussion

2. Given a presentation on arranging for product sales and distribution, and questions:
   a. Name at least three kinds of servicing information.
   b. Name at least five purposes of packaging.
   c. Name five out of eight types of advertising media.

Laboratory Activity

3. Given a lesson on product sales and distribution, fabricate a package that will protect, identify, display, and store individual high-intensity desk lamps. Produce and insert into the package a service manual for the lamp.

Time Schedule

5 Overview
10 Presentation
5 Discussion
25 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

1	15″ paper cutter
1	24″ bench rule
1	screen-stencil frame and stencil
1 ea.	templates for package, top and bottom
1	12″ rule
1	rubber squeegee
1	tape-cutting jig
2	wooden blocks, $1\frac{1}{2}''$ x $1\frac{1}{2}''$ x 15″
1	spirit duplicator, ditto machine
1	X-acto® knife
1	stapler, long throat
1	6″ scissors
several	sample service manuals of various products

Supplies (Group of 5)

10 ft.	masking tape *or* gummed-paper tape, 2″ wide
50 shts.	.030-gage, 14″ x 22″, chipboard or equivalent in oak tag, etc.
1 qt.	silk-screen paint, color selected by class
1 ball	string to wrap box
1 roll	1″ masking tape
50 shts.	duplicator paper
12 shts.	plain paper for stretching
2-4	spirit masters
1-2 pc.	lacquer-base stencil film
25 shts.	$5\frac{1}{2}''$ x $8\frac{1}{2}''$ colored construction paper
6 shts.	tracing paper

Overview (5)

1. Six days ago you had a lesson on production and quality control. Since then you've been working to assemble components of your lamp product.
2. Your reading concentrated on advertising, selling, and distributing operations and how they were planned and put into practice.
3. In the presentation, I shall emphasize the packaging of a product and the advertising and selling of a product.
4. You will be asked three questions in the discussion regarding the package, service manual, and advertising media.
5. One or two groups will begin work on a service manual and the package or box for your lamps. Other groups will continue in their centers as before.

Presentation (10)

1. As the desk lamps are completed, they must be packaged so they can be moved from the manufacturer to the consumers.
2. Advertising, selling, and distributing operations must also be planned.

328

3. The *reputation* of a product or "trade name" is important for *continued* business. Therefore, a manufacturer must provide adequate *service* for his customer to maintain and improve good will and repeat business.
4. Some form of product information must be provided so the consumer can intelligently *use* and *care for* his lamp. Usually this information is in the service or owner's manual for the product.

Discussion (5)

1. ,What type of information should be included in a service manual? (Operating instructions, warranty or guarantee information, service information, etc.)
2. For what purposes does a manufacturer package his product? (Protection, identification, display, storage, convenience, sanitation, etc.)
3. What advertising media might a manufacturer use? (Television, radio, magazines, direct mail, billboards, store displays, bumper stickers, neon signs, newspaper.)

Laboratory Activity (25)

Package

1. Students will need *two* templates, (see Teacher's Guide, 169-4; refer to Fig. 85-1 in Laboratory Manual), a pencil, 2 pairs of scissors, and a stapler to fabricate the package.
2. To cut chipboard, scissors or other hand-cutting tools may be substituted for utility knives.
3. When the package is closed with the product, etc. inside, tape it shut around the bottom edges. See Fig. 169-1 for use of a tape-cutting jig.
4. Save the screen stencil. It is to be used also in Production Center 11 to print the same design on service manual covers.

Service Manual

1. The service manual will be produced in the same manner as the autograph booklet, ACTIVITY 73B. If a spirit duplicator is not available, the manual can be printed on hectograph.
2. The teacher should remove from one Laboratory Manual, ACTIVITY 78B, Fig. 78B-3 of the exploded view. Make a heat spirit master for use by each class. Alternative method: have student trace it onto a spirit master.
3. The teacher should have sample warranties and service manuals available for students to study as samples.

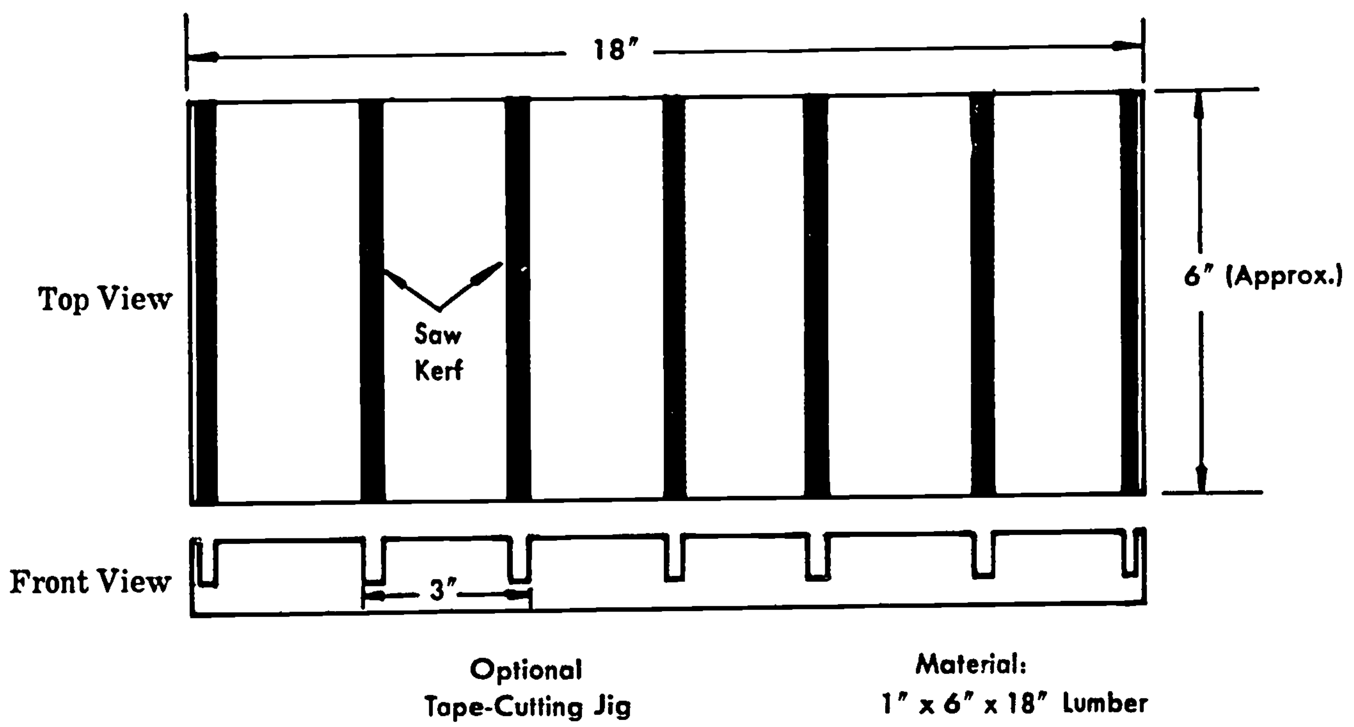


Fig. 169-1. *Optional* Tape-Cutting Jig
Material: 1" x 6" x 18" lumber.

Homework

None until Assignment 175. Then assign Reading 78, *Liquidating the Corporation.* Look ahead to Assignment 175, Activity 92. The presentation might be supplemented with a speaker such as an insurance agent, stock broker, bank employee, school business teacher, a relative with business knowledge, etc. The topic would be the system of checks and how they are used, and/or how an inventory works.

Notes

1. When screen stenciling is done, offer to stencil the trademark, time permitting, on students' book covers, T-shirts, sweatshirts, etc. Put paper inside a T-shirt too, so paint will "bleed" through on the back.
2. Uland® makes a water-base paint if you don't care for oil base.
3. Use heavy cardboard instead of the squeegee. It can be thrown away to save cleaning time.
4. See Fig. 169-2 for a silk-screen mask. Using an oak tag "mask" around the design saves much time in cleanup. Run the squeegee over the design to remove excess paint just before removal of the mask.
5. Fig. 169-3 shows several cover designs and shapes. Different shapes should be considered for good classes to figure out the layout and page numbers for a shape other than that given in the Laboratory Manual. For instance, a class could:
   a. add a page on which everyone's name was included and their jobs.
   b. include the corporation officers only.
   c. draw the laboratory layout for production.
   d. include some ads.
6. Mount instruction panels 10 and 11 for the students to see.
7. If you can get a special rubber stamp made, use it to add to the trademark or package. Examples: corporation address, "fragile," "handle with care," date, etc. Use the instructions in ACTIVITY 78A to make a complete rubber stamp from inner tube or your trademark if you prefer not to do silk-screen work.
8. There is a ¼″ difference in length and width for the top and bottom of templates. See Fig. 169-4. It needs to be only ¼″ for oak tag. A larger difference works best for chipboard and "thicker" stock.
9. One group of five students should take about seven class periods to do both the package and service manual. The teacher should help the group get started by doing the first package as a demonstration and folding the paper signature to show the group the relative positions of the pages, etc. Also review the use of ditto masters and the machine.
10. Consider making one group the advertising department. They can use crayons on colored construction paper, their corporation colors, etc. Ads, songs, cartoons, slogans, and jokes can be developed for the product.

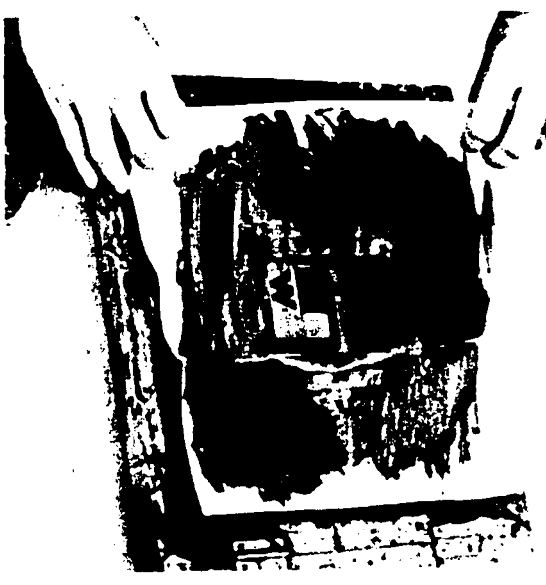


Fig. 169-2. Silk Screening Logo Mask
Note: Company design is termed "logo."

Fig. 169-3. Assorted Logo Booklets

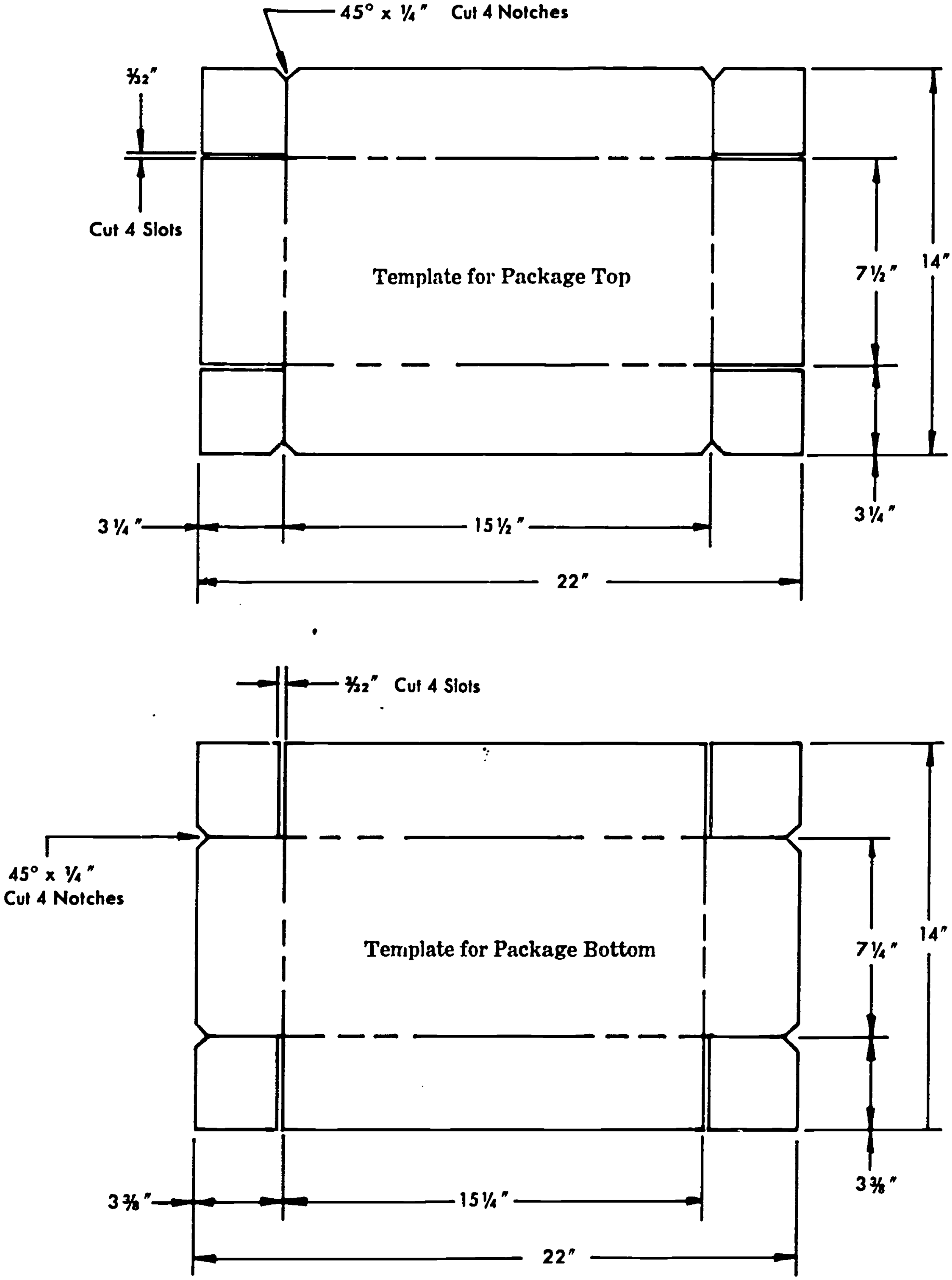


Fig. 169-4. Package Templates

Note: 1. Template of cardboard or sheet metal.

2. Notches are used for aligning the straight edge where sides and ends are folded.

ASSIGNMENT 175, ACTIVITY 86
REVIEW READING 77

Arranging for Distribution and Sales

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

1. Given the reading assignment and presentation, understand how to fill out a check, identify wholesalers and retailers, and describe an inventory.

Laboratory Activity

2. Given the task of beginning to close a business, begin liquidating the desk lamp manufacturing corporation by selling the lamps and taking an inventory of unused materials.

Time Schedule

5 Overview
15 Presentation
5 Discussion
20 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector w/screen

Supplies

1 Transparency 175, *A Personal Check*

Overview (5)

1. For the past several days you have completed combining subassemblies for your product.
2. The current text reading provides you with information about selling and distributing operations.
3. In ACTIVITY 85, Arranging for Distribution and Sales, we emphasized the package. Today our presentation concerns the sales of the product.
4. You will be asked several questions about checks, purchasing the product, and inventory. In your laboratory activity today, you will purchase your lamp and help take inventory of a list of unused materials.

Presentation (15)

This is the day you will simulate the purchase of your product by personal check and take it home with you. An inventory will be taken of surplus materials.

1. Instead of using cash or play-money, you will complete a personal check to pay for your lamp. NOTE: The teacher should indicate that the use of a check provides a receipt for the product, as well as eliminating the necessity to carry large sums of money which could be lost or stolen.
2. Look at Transparency 175, *A Personal Check*. When you purchase checks from a bank, your name and address are printed on the face of the checks (in this case, in the upper left-hand corner). *You* will fill in this information this time. (Refer to Fig. 86-2 in the Laboratory Manual.) Your check number is put in the upper right-hand corner. (Use overlay.)
3. *You* fill in the date, using today's date.
4. $\frac{91\text{-}304}{1221}$. 91 is the city of Phoenix, Arizona. 304 is the number of one bank in a specific town. 1221 is the Federal Reserve District. In this case, it is the Los Angeles, California District.
5. After "Pay to the Order of," fill in the name of your corporation. You are paying them for the lamp.
6. After the dollar sign, put $4\frac{75}{100}$. This is four dollars and 75 of 100 pennies, a fraction of a dollar. Be sure to place the 4 as close to the dollar sign as possible so additional figures cannot be inserted.
7. Write out this amount before "dollars" to reestablish the amount of the check *in writing*. Again start writing as far left as possible to prevent a change of the figure.
8. The bank usually prints its name in the corner with its trademark.
9. You sign *longhand* in the lower right corner. Sign as your name appears on

all legal documents such as a birth certificate. It is your personal trademark.

10. The lower left set of numerals is (a) the Federal Reserve District in which the bank is located, (b) the town, and (c) the specific bank number.
11. The middle set of numerals is your checking account number.
12. Now place the overlay of Transparency 175-1. Check over to show the students a *completed check*, front side.
13. The right set of numerals is the amount of the check printed on *after* the check has been paid and the bank receives it from the endorser, the person who receives the money.
14. Magnetic ink is used for the bottom three sets of numerals. A computer "reads" this ink and automatically sorts checks and does all figuring on your account.
15. Inventory is the process of counting all your supplies, materials, etc., to determine the exact value of what you have on hand.
16. When purchasing, the *wholesaler* buys in quantity at less price per item. The *retailer* buys from the wholesaler in smaller quantity and pays more per item. Part of the extra cost to the retailer is the wholesaler's profit. You buy from a retailer, the store.

Discussion (5)

1. On a check, what goes on the line "Pay to the Order of"? (The name of the person or organization to whom the money is to be paid.)
2. What is the last magnetic ink to go on the check? (The amount of the check, in the lower right-hand corner.)
3. Per item, does a wholesaler or a retailer pay the higher price? (Retailer.)
4. *Counting* what you have on hand, etc., to determine the total value of your assets is called what? (Inventory.)
5. Why is placement of both printed and written figures critical on a check? (To prevent a change in the amount of the check.)

Laboratory Activity (20)

Today, the students will purchase their products with simulated personal checks and complete an inventory preparatory to liquidating their corporation in the next activity.

1. Have each student purchase a lamp by preparing a personal check. NOTE: Lamps should be withheld from students until the end of the period.
2. Have the students complete the inventory in Fig. 86-4, Inventory Accounting Sheet and Inventory, in their Laboratory Manual. NOTE: The total for the inventory is $22.00.
3. Help the students with the math where needed.

Homework

Reading 79, *Liquidating the Corporation*

ASSIGNMENT 176, ACTIVITY 87
READING 78

Liquidating the Corporation

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information on liquidating the corporation:
   a. Look in the local newspaper for corporations that are going out of business and give the reasons why they are going out of business.
   b. Describe how corporations in the community are helping to fight air and water pollution.

Discussion

2. Given a balance sheet, state one difference between the balance sheets of liquidated and nonliquidated corporations.
3. Given the corporate worth and the number of stockholders of a corporation, calculate a final dividend for each stockholder.

Laboratory Activity

4. Given the necessary corporate records, balance the lamp corporation books and dissolve the corporation.

Time Schedule

5 Overview
15 Presentation
5 Discussion
20 Laboratory Activity

Overview (5)

1. Your last lesson afforded you a chance to fill out a personal check for your lamp and complete a balance sheet. All products were taken home.
2. From your reading you learned that when a corporation is to be dissolved, its assets must be *liquidated*: converted to cash. The dissolution or "dissolving" of the corporation may be *voluntary* or *involuntary*.
3. Today I will discuss the legal process of liquidating a corporation.
4. Be prepared to answer several questions in the discussion that will focus upon the legal process of liquidating a corporation and the balance sheet.
5. The laboratory activity consists of preparing a corporate check for the final dividend payment, arriving at the amount of the final dividend from a balance sheet.

Presentation (15)

Liquidation is a legal process of settling a corporation's accounts by dividing assets and debts. When a corporation is liquidated, all assets are converted into cash and the amount is entered in a final balance sheet.

1. After the decision to liquidate is made, several steps in *accounting* must be taken:
   a. All sales money is accounted for.
   b. All unsold products are accounted for.
   c. All materials and supplies are accounted for.
   d. All equipment is accounted for.
2. A *reduced price* is set for unsold products, materials, and equipment.
3. All material assets are sold.

Liquidation Involves

1. Selling the corporation's assets. The cash obtained is shown on the *balance sheet.*
2. The corporation's books are balanced, to account for all the assets in *cash* form.
3. The cash assets are transferred to the stockholders' *equity,* and the stockholders' equity in the liquidated corporation is distributed.
4. The balance sheet for the lamp corporation in ACTIVITY 79 showed some liabilities and assets, including equipment and materials purchased to make desk lamps. Regular accounting practices would enter other assets, such as the plant equipment.
5. The balance sheet is completed. It includes all money made from *sales* of lamps and unused materials.
6. The balance sheet *cash* totals are transferred to the stockholders' equity.
7. The balance sheet shows all the assets *converted* into money.
8. The balance sheet also shows all *debts* of the corporation *paid out.* These debts normally include taxes and other expenses, but for our class purposes no

taxes or other expenses are included. The total remaining money is the total equity.
9. The total equity is divided among the stockholders.
10. Checks are sent out to the stockholders as a final dividend.

In review, *corporation efficiency* includes closing the business in an efficient manner. The steps followed in liquidating the corporation are:

a. The *decision* is made for dissolution.
b. *Inventory* is taken.
c. The various *sales* are made.
d. *Payment* is made to stockholders.

Discussion (5)

In order to *liquidate* the corporation, the assets of the business are converted into "liquid assets" or *money*.

1. What is a *balance sheet*? (An accounting form showing all the assets of the business.)
2. What does the *final balance sheet* of the liquidated corporation show? (It shows all assets converted into cash. No materials, tools, or unsold products remain.)
3. What happens to the *cash totals* shown on the balance sheet? (They are transferred to the stockholders' equity.)

Laboratory Activity (20)

Today the students will account for the *total assets* and *liabilities*, and *liquidate* the corporation.

1. Have the students refer to Fig. 87-2 in the Laboratory Manual, the balance sheet, and study the form.
2. Have the students "account for" all assets by entering the cash amounts for each item. Have the *board of directors* read each item and *lead* the class in any calculations.
3. Have the students check their totals.
4. Have the *president* open the stockholders' meeting and follow the procedure for liquidation, as given in the Laboratory Manual.
5. This activity is best performed with all students seated except the president.

Homework

Reading 79, *Manufacturing in the Future*

Note

Inform the students that three periods from now, including the review lesson, there is the Comprehensive Final *for which they should begin to study*. It will be 50 multiple-choice questions on Readings 1-80.

ASSIGNMENT 177, ACTIVITY 88
READING 79

Manufacturing in the Future

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about manufacturing in the future:
   a. Describe how manufacturers of the future will use materials over again and tell how this will affect the pollution problems we are facing now.
   b. Identify jobs in the community that are changing as a result of technological progress.

Discussion

2. Given an illustrated presentation-discussion, the students will volunteer to discuss their ideas for school courses that would best prepare them to understand manufacturing in the future.

Laboratory Activity

3. Given an illustrated presentation, each student will list five suggestions for new manufactured products and be prepared to discuss his ideas with the class.
4. Given a display of products manufactured in class, each student will be prepared to suggest improvement in our product designs during class discussion.

Time Schedule

5 Overview
20 Presentation
5 Discussion
15 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 slide projector/screen

Supplies

1 Filmstrip No. 177, *Manufacturing in the Future*

Equipment and Supplies for Laboratory Activity

Supplies (Class)

25 pcs. scrap paper, for listing five suggestions for new products

Overview (5)

1. Yesterday we completed the steps necessary to liquidate the corporation.
2. Today we will consider some of the materials, processes, and products that may be important in manufacturing in the future.
3. Vast new frontiers of products and manufacturing technology are beginning to appear.
4. In the future you will be very much concerned with the knowledge and skills needed to hold the kinds of jobs that will be available.
5. I will present a filmstrip that shows some of the possible products and manufacturing technology you may expect to see in your lifetime.
6. Our laboratory activity will encourage you to think of possible future products and improved manufacturing technology.

Presentation (20)

Note

The teacher may expand on the script as additional comments seem appropriate.

Script for Filmstrip No. 177 — 28 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Manufacturing in the Future*
   This filmstrip presentation will show concepts of the material world that man will probably manufacture in the future. As we view the filmstrip, try to think of the kind of education you will need to live and work in this world of the future.
5. We are already familiar with nuclear power plants, but have you thought

336

about the simplicity of using ocean tides to develop hydroelectric power for manufacturing plants near our seacoasts? This source of power requires an alternate system to be used during tide change of direction.

6. There may be houses manufactured in wall sections to be assembled like your slot car kits. This concept is not new, but imagine these wall sections cast or molded in a period of minutes on a moving production line.
7. Construction workers are mainly assemblers at the site where the structure is needed.
8. Entire cities can be built inside plastic, air-conditioned domes to provide a suitable environment for man.
9. Transportation may include automobiles floating above a roadway by electromagnetic repulsion.
10. A development for the immediate future may be the super flywheel car. The flywheel is rotated or charged to a very high speed by an electric motor. The flywheel then drives a generator which powers an electric motor at each wheel of the car. The car runs for two hours without recharging.
11. Most spectacular, perhaps, will be the extensive use of rockets for freight and passenger service between continents and to other planets.
12. Air-breathing scramjets with wings may lift the rocket to near orbital speed, then return to the launching site while the rocket continues under rocket power. A still more fantastic rocket age will begin with the use of nuclear power to propel rockets.
13. Food may be processed from plant life harvested from the sea.
14. Minerals also will be extracted from the sea. The sea is already our prime source of magnesium.
15. In the future, many manufactured goods will be disposable rather than repairable or reusable. Imagine a crumpled automobile fender corrected by replacing the entire body shell made of molded paper reinforced with new plastic materials.
16. Extensive use of electrochemical machining by which metals are shaped with great accuracy will replace much of present machining practices.
17. Electrical discharge machining where holes in metal are made to very close tolerances will be more widely used.
18. The laser beam will become economical for cutting metals.
19. Microminiaturization of electronic circuits is an industrial process that fantastically reduces weight and size of electronic communication and control units. For example, imagine a pure silicon semiconductor wafer 1″ in diameter, and one-hundredth of an inch thick with 125 transistorized microcircuits. Each microcircuit contains 12 transistors, 36 diodes and numerous resistors. (Compare this with tube components.)
20. Some products will be manufactured in space. (Picture of space-type factory shows rocket transport docking with supplies.) Rocket freight transportation will be essential.
21. Due to lack of gravity in space, ball bearings can be made perfectly round. Liquids of different weights can be easily mixed since there would be no gravity to settle a heavier liquid.
22. Metals can be melted and highly purified (gold). Better crystals for the laser beam can be grown or manufactured in space.
23. Products in the future will be manufactured largely by automated machines controlled by computers.
24. New products, new machines, and new jobs will appear rapidly to replace or add to the previous manufacturing technology. How can you prepare for this new world?
25. We know that research, design, engineering and servicing of machines and products of machines will continue to be important. Technicians will do much of the work formerly done by engineers and other professional people. These people will know a lot about limited areas of the professional person's work. They will know something about a *lot* of different processes and practices in manufacturing so that they can adapt their skills to new jobs with a minimum of on-the-job training.
26. The technician in manufacturing will have a basic knowledge of power systems and the mechanics of energy control applied to automation.
27. He will have a working knowledge of

communication techniques used in manufacturing.
28. Probably most jobs in manufacturing in the future will be interesting and well-paid, but you will need a broad type of training combined with some specialization in a particular area to perform the work.

Discussion (5)

We have viewed some of the probable developments in manufacturing in the future.

1. What subjects in school would probably contribute most to your understanding of manufacturing and manufactured products in the future? (Answers will vary, but industrial arts of the IACP type and the science courses will be very important to an understanding of the man-made world of the future.)
2. What information and activities should these courses contain? (Answers will vary. A broad coverage of concepts and lots of student activities that simulate industrial applications will be necessary.)

Laboratory Activity (15)

Problem 1

1. Distribute scrap paper and have each student list five products not now on the market that might be manufactured in the future. (Suggest one, such as solar batteries.)
2. Select students to present their ideas and lead class discussion toward development of design specifics and production techniques. Use about 10 minutes of class time.

Problem 2

1. Display as many of the main products of the course as feasible.
2. Review a few of the concepts involved with each product and ask individuals in the class to suggest improvements in design. Suggestions of merit may be listed by a group recorder and delivered to the teacher for possible product revision.

Option

Films that may be available and appropriate for manufacturing in the future may be substituted for the laboratory activity.

Homework

Review of Readings 1 to 82

ASSIGNMENT 178, (OPTIONAL)
REVIEW READINGS 1-80

Review No. 10

Objectives

As a result of their learning experiences, the students should be able to do the following:

Discussion

Given the summaries of Readings 1-80, ask and answer questions about management, personnel and production, and the manufacturing corporation.

Time Schedule

45 Discussion

Discussion (45)

1. Divide the class into their regular groups of five. Have students spend about 10 minutes looking through the textbooks and listing five questions about concepts or words they would like to have clarified.
2. Have the foreman of each group present the questions for discussion.
3. Use these questions as a basis for leading the group discussion.
4. Review any important concepts about which the students did not pose questions for either semester.

Homework

None

ASSIGNMENT 179

Comprehensive Test

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given a fifty-question Manufacturing Comprehensive Test, Final, apply knowledge of manufacturing technology by answering 70 percent of the questions correctly.

Time Schedule

45 Laboratory Activity

Laboratory Activity (45)

1. Seat the students to best advantage for administering the test.
2. Distribute pencils, erasers, etc.
3. Place the test and answer sheet upside down on each student's desk.
4. At your command, have students turn over the tests and answer sheets.
5. Follow directions as given with the test.
6. Allow 35 minutes for completion; then collect test papers.
7. Review the test with students.

Note

It may be necessary to extend the test to 40 minutes, if possible, and eliminate the review of Step 7 for today. Since the test is longer than usual, it may require the extra time. Then review the test the first part of the next period and shorten some part of the lesson.

Homework

Reading 80, *The Story of Basic Machine Tools*

Note

If grades must be submitted now for final report cards, students should not be told this. The next assignment begins the first of three studies of selected industries to complete the school year. Student's work in these days should be considered at the discretion of the teacher toward a final grade. Should the lamp require additional time to complete, work on it might be substituted for some of the studies of selected industries.

Answers to Comprehensive Test

1. A	2. C	3. B	4. D	5. B	6. A	7. C	8. D	9. B
10. C	11. A	12. D	13. B	14. C	15. B	16. A	17. B	18. D
19. C	20. D	21. A	22. B	23. A	24. D	25. B	26. A	27. B
28. C	29. A	30. D	31. B	32. D	33. D	34. A	35. A	36. B
37. D	38. D	39. C	40. B	41. A	42. D	43. C	44. B	45. C
46. B	47. B	48. D	49. C	50. D				

ASSIGNMENT 180, ACTIVITY 89
READING 80

Story of Basic Machine Tools

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about the story of basic machine tools:
   a. List five parts of an automobile that were manufactured using basic machine-tool techniques, special machine-tool techniques, and a combination of basic and special machine-tool techniques.
   b. Explain what courses you would take in high school and beyond high school that would help prepare you to enter the machine-tool industry.

Discussion

2. Given six basic kinds of processes performed by machine tools, identify the principle of each process and give an example of each.

Laboratory Activity

3. Given illustrations of five basic machining *practices* and the corresponding names in a separate column:
   a. Match each illustration with the proper name.
   b. Name three practices not shown.
   c. Identify three descriptions that apply to machine tools.

Time Schedule

5 Overview
20 Presentation
10 Discussion
10 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 overhead projector/screen

Supplies

1 set Transparencies:
180-1. *Drilling and Boring*
180-2. *Turning*
180-3. *Milling*
180-4. *Grinding*
180-5. *Planing, Shaping, and Broaching*
180-6. *Other Processes*

Overview (5)

1. Your reading explained that the machine-tool industry is one of our most important industries.
2. In the next few days, we will learn about several important industries. This will finish your course in Manufacturing. We will begin with the story of Basic Machine Tools.
3. You will see on transparencies the six basic kinds of *machine tools*, the purpose of each machine, and common examples of practices.
4. You will be asked questions about the six basic kinds of machine tools and their use.
5. In the laboratory activity you will match illustrations with the names of machine tools.

Presentation (20)

Today's presentation will cover (1) drilling, (2) turning, (3) milling, (4) grinding, (5) planing and shaping, and (6) forging, shearing, and pressing. A suggested script to accompany the six transparencies follows. You may wish to *supplement* this presentation or discussion with a machine demonstration,* if the machine is available.

1. Transparency 180-1, *Drilling and Boring*. *Drilling* is a basic kind of machine process. Drilling consists of making a round hole by means of a rotating tool. Point out drilling on Transparency 180-1.

---

*NOTE: You may demonstrate the operation of a lathe, shaper, special grinder, or mill. If no machine tools are available, demonstrate tapping; use of a router as a mill; use of a chisel or plane as a shaper; etc. Emphasize that the demonstration of a hand tool only illustrates a *working principle* of a machine tool; a hand tool is *not* a machine tool.

Boring is a drilling process. Boring finishes a hole that has already been drilled or *cored,* a cast hole, by means of a rotating, offset single-edge tool. Point out boring on Transparency 180-1.

Tapping is closely related to drilling. Tapping is the cutting of threads inside a hole, so that a threaded bolt or screw may be used.

Threading is the cutting of threads on the outside of a piece of stock.

2. Transparency 180-2, *Turning*. *Turning* is usually performed on a lathe. A lathe is primarily used to produce *cylindrical* (round) parts. The workpiece is rotated and the cutting tool advances against it, separating some material from the workpiece.
3. Transparency 180-3, *Milling*. A *milling* machine removes metal by moving the workpiece past a rotating, multiple-edged cutting tool. There are two ways of milling: *vertical* and *horizontal*. Milling can produce slots and flat or complex surfaces, depending on the cutting edge of the tool. A table saw represents the milling principle.
4. Transparency 180-4, *Grinding*. *Grinding* is another basic kind of machine-shop process. A rotating, abrasive wheel (synthetic or natural) separates small pieces from the workpiece. Grinding usually produces a fairly smooth surface. Sometimes grinding is referred to as *abrasive machining* or *abrading*.
5. Transparency 180-5, *Planing and Shaping*. *Planing*, *shaping*, and *broaching* are three closely related practices; in either practice a single blade or tool removes chips as it contacts the workpiece. The basic difference between a planer and shaper is movement. On a *planer*, the tool is stationary and the workpiece moves. On a *shaper*, the workpiece is stationary and the tool moves. In *broaching*, the workpiece is stationary and the tool moves. All have linear tool movement. Using a wood plane, chisel, or Surform® file are everyday examples.
6. Transparency 180-6, *Other Processes*. *Forging*, *shearing*, and *pressing* are special machine-tool practices. An example of forging is the squeezing of white-hot metal in a die under great pressure. Shearing is the separating of material without a loss of material. Pressing is the removal of special shapes from a larger sheet of material. A punched hole is an example.
7. Machine tools and hand tools work on the same principle. For example, you may turn an apple in your hand and peel it with a pocket knife in a way that is very much like the operation of a lathe. Or you may use abrasive paper to do the same kind of work that a grinder does. Two important differences are that a machine tool is *power driven* and is not held in the hand.

Discussion (10)

1. What is a *machine tool*? (A power-driven machine, not portable by hand, used to shape or form metal by cutting, impact, pressure, electrical techniques or a combination of these processes.)
2. What are the five *basic* kinds of machine tools? (Drill, lathe, milling machine, grinder, and planer or shaper.)
3. Give some examples of *special* machine tools in common use today. (Press, press brake, shear, drop hammer, steam hammer, punch press.)
4. Give some examples of *special* machine tools that are just *beginning* to be used extensively. (Electrical-discharge machining, electrochemical machining, explosive forming, ultrasonic cutting and forming, hydroforming, and electrolytic machining.)

Laboratory Activity (10)

The students are to summarize their knowledge of machine tools by answering their Laboratory Manual questions.

Homework

Reading 81, *Story of Rubber Products*

Note

Have an old whitewall tire ready and cut into three or four pieces to show cross sections for use in Assignment 181.

Answers for Laboratory Manual

1. D — drilling and boring
   C — turning
   A — grinding
   B — milling
   E — planing and shaping

341

2. a. Forging
   b. Shearing
   c. Pressing

3. a. Not portable by hand
   b. Power-driven machine
   c. Used to shape or form material by cutting

ASSIGNMENT 181, ACTIVITY 90A
READING 81

Story of Rubber Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Using information about the story of rubber products:
   a. List all of the products you used today that are made of rubber or that contain rubber parts.
   b. Name some products or components that are now made of another material that might be replaced by rubber or rubber parts.

Laboratory Activity

2. Using a filmstrip, "Story of Tires," demonstrate comprehension of how tires are made by correctly answering at least five of six questions related to the filmstrip.

Time Schedule

5 Overview
10 Demonstration
25 Presentation
5 Laboratory Activity

Equipment and Supplies for Demonstration and Presentation

Equipment

1 pr. scissors (any size)
1 pr. slip-joint pliers (any size)
1 whitewall tire (old discard, any size), cut into sections
1 filmstrip projector/screen

Supplies

1 jar 13 oz. size, rubberized vinyl (any color)
1 Filmstrip 181, *Story of Tires*

Overview (5)

1. *Natural* rubber or latex is tapped from rubber trees. *Synthetic* rubber is *manmade*. There are five major groups of rubber products, based on the manufacturing processes: *dipped, molded, reinforced, stamped* or *cut*, and *foam* products.
2. Today you will see a demonstration on the use of a *synthetic rubberized vinyl (plastic)* to cover the handles of a tool. Then you will see a filmstrip on the *Story of Tires*. The filmstrip is about a *reinforced* rubber product, the *tire*.
3. In the laboratory activity you will answer questions relating to the filmstrip. You are expected to get five of the six questions correct.

Demonstration (10)

This demonstration concerns one use of a *synthetic* rubber product, rubberized vinyl.

1. Have ready on the demonstration table a 13-oz. jar of rubberized vinyl (plastic), a pair of scissors, and/or a pair of slip-joint pliers.
2. Explain that this is a *synthetic* (man-made) rubber, as opposed to *natural* rubber. You will be using a dipping operation, which students will use tomorrow to make balloons.

3. Dip the handles of the scissors and/or pliers, as explained in the directions on the container. In 10 minutes the rubberized vinyl should be dry. Pass the scissors and pliers around after the filmstrip presentation is completed.
4. Show some tool(s) which have had the handles dipped by a manufacturer. Your pop rivet gun and some electrician's pliers are examples, perhaps.
5. See if the students can name other products, such as rubber gloves, made this way. Remind them that rubber gloves are made with *natural rubber* (latex) and are peeled off the mold.
6. Proceed to the filmstrip.

Presentation (25)

1. Pace yourself timewise, as you have 36 frames to show in 25 minutes.
2. Have an old automobile tire (whitewall preferred) cut into three or four sections for students to look at before the filmstrip begins or while you begin the filmstrip. The tire cross sections make an excellent visual aid for this filmstrip. Cut the tire with a hacksaw.

Script for Filmstrip No. 181 — 36 Frames

Frame
No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Story of Tires*
   Tires are one of the products manufactured by rubber companies.
5. When a new tire is planned, the *tread design* must be developed. This plaster pattern will be used to make molds in which tires are shaped and *vulcanized.*
6. The *design* of a tire is influenced by its use. A spare tire is folded on its rim until inflated. It is designed to fit in a compact space.
7. The aircraft tire's *design* was influenced by a needed characteristic. It has a fender between its tread and sidewall. The tire was designed to keep airplanes from splashing themselves during takeoff and landing on wet runways.
8. Tires as used on the B-70 airplane must be designed to withstand *high temperatures.* To prove this tire's ability to stand the heat generated by air friction at speeds three times the speed of sound, the tire was exposed to temperatures of 360° F. for several hours, then "landed" while still hot. The tire was hot enough to boil water. (Water boils at 212° F., at sea level.)
9. Tires are *tested* in many ways. The engineer uses a potentiometer to measure tread *temperature*. This tire has been run an hour at 115 miles per hour in a laboratory wheel test. This particular tire runs 20 percent cooler than regular tires at high speed. It is used specifically for police cars.
10. Tires are *tested* in many ways before they are put into production. This machine takes a tire through all kinds of *turns* to simulate the effects of driving.
11. In another type of test, tires are tested in terms of the amount of force required to *pull each wire* from the cured rubber base. This determines the suitability of the wire for use in tire beads. The bead is the metallic part of the tire which fits into the rim and, with the aid of the air in the tire, locks the tire to the wheel. The lady's arm shows how high the wires are pulled in this test.
12. Tires are also *tested* on cars. Technicians send a test car into a controlled skid on a *skid*-testing track.
13. This industrial tire is made to be used in scrap metal yards, glass works, and other tire-destroying industrial operations. The tire contains two layers of steel cables under the tread.
14. This drawing shows the four major parts of the tire. You will see how each is made in a modern tire plant. The four parts in order of manufacturer are: (1) *tread,* (2) *beads,* (3) *air-retaining liner,* and (4) *plies.*
15. The first step in the actual manufacture of tires comes when raw materials are mixed in a *Banbury mixer*. More than 100 different chemicals are used in the compound of a modern tire. Notice that the materials are weighed as they are moving along the conveyor.
16. While the raw rubber and chemicals are

being *compounded*, the tire beads are being made by feeding steel wire around several reels on which the wires are aligned side by side. The wires then pass through an extruder where they are enclosed in rubber.

17. Here a *bead maker* is forming the rubber-coated wire into a bead to be used later in the building of a tire.
18. Meanwhile, the *tread* of the tire is being *compounded* to resist wear and abrasion. The compounded tread stock is put through a warm-up mill to make it soft, pliable, and tacky. Then it goes to a strip feed mill, which rolls it to a prescribed thickness.
19. The strip feed mill forces the compounded tread stock through an *extruder die*. It is now a continuous strip, thick in the center with tapering wings on each side. The thick portion is the tread proper; the wings will form the sidewalls of the tire.

    After the rubber is extruded and cut to width, it passes through a long tank of water to remove heat generated by milling and extrusion. After cooling, the tread stock is *cut* into proper lengths and stored for use by the tire builder.
20. While the tread and bead are being made, so is the *air-retaining liner* which replaces the tube in tubeless tires. It is made of a dense rubber compound to hold air in the tire. After the liner is made soft on a warm-up mill, it is passed on to a strip-feed mill where it is shaped into a strip of the proper width and thickness. The strip then enters a gum calender where it is rolled to the exact thickness and width for the various tires being manufactured. After leaving the gum calender rolls, the rubber is wrapped up in cotton cloth to prevent it from sticking to itself. The liner stock is ready for the tire builder.
21. A tire made entirely of rubber would not be strong enough to retain the air pressure to support the load. The rubber is *reinforced* with fabric plies, principally *nylon* and *rayon*. This photo shows the cloth being unrolled, passed through an adhesive dip, and then dried. The dipped fabric is then coated with rubber.
22. Here the continuous six-foot-wide *strips* of tire fabric are *dried* after dipping. The cloth is processed under tension to assure a high level of quality in the fabric. The fabric is then wound up in a cloth, as the liner was, to await being built into a tire.
23. The prefabricated beads, liners, ply materials and tread come together at *build-up*. This tire builder is putting on the tread. Notice the white wall on the tire builder's right. It is covered by the sidewall until after curing, when it is ground open to expose it.
24. Tires are *molded* and *cured* with steam heat and pressure in a curing press. This press contains molds with steel dies that form the bead design. In front of the press are two "green" tires. The "green" tires in the machine are ready to be molded. The curing temperatures of tires vary from 260° F. to 388° F., and the time varies, depending on the size and type of tire.
25. This is a close-up of a pair of *tire molds* after a tire has been cured. Notice the deflated bladders in the center of each tire. During the curing operation the bladders inflate to hold the inside of the tire open. The tires now need to be trimmed, inspected, and prepared for distribution.
26. This *tire-curing press* cures, inflates, cools, and tempers the tire.
27. Here the "still warm" tires are moved by *conveyor* to storage.
28. Tire manufacturers make *all types of tires* from bicycle tires . . .
29. . . . to huge tires for earthmovers. (This tire is cured from both inside and the outside because of its size.)
30. Some tires, such as truck tires, still use *inner tubes*. Tubes are also produced by the tire manufacturer.
31. After tires are manufactured they may be shipped immediately by rail or truck. An *inspector* is checking a boxcar load of studded snow tires. Notice how the tires are interlocked in each other to prevent damage and shifting during shipment.
32. Some newly manufactured tires are *wrapped and stacked* on pallets. Lift trucks are used to move the pallets to their place of storage in the plant warehouse.
33. Some tires require individual handling. This tire is nine feet high and weighs

2,900 pounds. A tire of this type weighs as much as 140 auto tires.
34. The man is dwarfed by this enormous machine with large tires. This *mobile gantry crane* is 13 stories high. The tires each weigh 6,000 pounds and are 10′ high and 5′ wide. They are the world's largest tires.
35. Tires have come a long way down the road of development. The young lady on the right holds the first cord tire, while the lady on the left holds a modern-day tire.
36. Credits

Laboratory Activity (5)

1. Students should answer the questions in the Laboratory Manual.

Homework

None

Note

Look ahead to Assignment 184.

Answers for Laboratory Manual

1. Any three destructive tests: skid; heat; tire bead; and endurance.
2. Tread, beads, air-retaining liner, plies (in any order).
3. Compounding
4. Banbury mixer
5. Trucks, passenger cars, tractors, earthmovers (other answers are acceptable).
6. Nylon, rayon
7. a. 6,000 lbs.
   b. 10′ high
   c. 5′ wide

Story of Rubber Products

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Given the necessary equipment and supplies, manufacture balloons, a dipped rubber product.

Time Schedule

5 Overview
40 Laboratory Activity

Equipment and Supplies for Laboratory Activity

Equipment (Group of 5)

2 small test tubes
and/or
2 25W or 40W light bulbs *and/or* Christmas tree bulbs for molds
1 5-qt. plastic bucket
1 watch or clock with second-hand

Supplies (Group of 5)

2 paper cups, approx. 12-oz. size. Obtain 12-oz. *cups* and *lids* from local hamburger chain
2 pcs. 6″ x 6″ plastic film *or* snap-on cup lids
10 oz. No. 545 coagulant, clear*
10 oz. No. 60-1231 latex, blue*
1 can talcum powder, for the class

*Teacher needs 1 qt. of each, for all classes.

Equipment (Class)

1-2 heat lamp(s)

Overview (5)

1. In the last class meeting we emphasized *synthetic* rubber and a *reinforced* rubber product, the tire. You saw a filmstrip on how tires are made and had a chance to see a piece of tire cross section.
2. In today's laboratory activity, you will perform a *dipping* process to manufacture a rubber product, a balloon. It will be from *natural* rubber, latex.

Laboratory Activity (40)

The teacher will need to move from group to group, to help with the activity.

1. Assist the class and keep the activity moving, so that all balloons can be dipped, washed, cured, and removed from the mold by the end of each period.
2. One quart each of latex and coagulant will be about enough for all classes performing the activity.
3. Have the students answer their Laboratory Manual questions when they are not directly involved in the activity or in cleaning up.
4. Caution should be used in the drying, curing, of the balloons on the molds. Temperature from 160° F. to 220° F. will be sufficient. In any case, do not get too close to the heat source — especially a furnace.
5. At the end of the period, all molds must be stripped so that they are ready for the next class.
6. It is suggested the teacher carefully go over this activity in the Laboratory Manual with the class. The students should be cautioned to read and follow *every* step carefully for the *whole* activity.

Safety Precautions

1. If a soldering furnace or other type of furnace or heat source is used in addition to the heat lamp, be sure to wear safety glasses and do not get close to the open flame.
2. If the liquid latex smells like rotten eggs, it is spoiled. If it has an ammonia odor, it is useable.
3. If the liquid latex is spilled, it can be cleaned up immediately with water. Otherwise, allow it to dry and then peel it up.
4. If liquid latex is spilled on clothes, wash it out *immediately* with water. It is almost impossible to remove otherwise. If this should occur, have the student inform the dry cleaner that the soiled garment contains latex.

Homework

Reading 82, *Story of the Telephone*

Answers for Laboratory Manual

1. Because the mold is dipped into the liquid latex.
2. Rubber gloves, rubber dolls, etc. Answers will vary.
3. Latex
4. Larger molds
5. Man-made, as opposed to natural rubber.

ASSIGNMENT 183, ACTIVITY 91A READING 82

Story of the Telephone

Objectives

As a result of their learning experiences, the students should be able to do the following:

Text

1. Given information about the story of the telephone:
   a. Name the local telephone company and determine if it is an associated company of the Bell System or if it is an independent company.
   b. Describe some of the challenges that lie ahead for the telephone industry and describe the resulting changes.

Laboratory Activity

2. Given diagrams of old fashioned and modern telephone systems, determine the number of circuits required for each.
3. Given a 3/4" telephone harness, count the wires and record the color combinations.
4. Given six questions about the laboratory activities, answer five questions correctly.

Time Schedule

5 Overview
25 Presentation
15 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 filmstrip projector/screen

Supplies

1 Filmstrip 183, *The One Big Machine*
1 Chart 183, The Telephone Story

Equipment and Supplies for Laboratory Activity

2 pcs. 3/4" telephone multiwire cable harness, approx. 2' length

Overview (5)

1. In our last class we learned about natural rubber, latex, and made a dipped rubber product, a balloon.
2. Your textbook reading described the parts of a telephone system, including stations, circuits, and switching centers.
3. You will see a filmstrip called *The One Big Machine*, which is all about the nation-wide telephone system.
4. Today's activity concerns how a local telephone system works. You will diagram station connections for an old fashioned system and compare it with a modern one. You will also examine a telephone harness, count the number of wires in it, and record the number of color combinations.

Presentation (25)

Today's filmstrip is called *The One Big Machine.*

1. Explain that the "big machine" is the telephone system.
2. The filmstrip contains 36 frames to be presented in 25 minutes. Pace yourself accordingly.
3. Use the Bell chart, The Telephone Story, in frame 5 as a supplement.

Script for Filmstrip No. 183 — 36 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *The One Big Machine*
   We have learned that the familiar telephone set is just one part of a huge network or system. Perhaps it would be clearer if we build our own telephone system.
5. Here are two telephone sets connected by a wire. We called the *telephones "stations"* and the *wire a "circuit."* A telephone system has stations and circuits to connect the stations. That is all a system needs — *if there are only two stations.* (Use the Bell chart, "The Tele-

phone Story," to show the phone's development.)

6. But now we have three stations in our network. The thin white lines still show the circuits needed to connect each phone to the other two. The thick lines show how they might be connected to a *switching center*. The switching center is represented by the red square in the middle. The switching center makes the connections, linking one station with another. Let's add more stations onto this network and see what happens.
7. Now we have nine stations. See how complicated the thin white lines have become. Compare them with the simple, direct pattern of the wide lines which connect each station to the switching center. This nine-station network has 36 possible different connections.
8. More than 100 million telephones and other station devices in this country are *linked* together through a *single nationwide network*. This network might be thought of as a giant *computer*, the world's biggest! Or you might want to call it "One Big Machine." It can make *5 million-billion* different connections.
9. Let's look at how this network transmits a call from New York to Los Angeles. There are a great many *circuits* that the call can take. The switching centers will try to send the call by the most direct way first. If the circuits are all in use, the call will be routed *another* way. For example, if this call cannot go through Cleveland, Chicago, and Denver, it might be sent via Miami, Houston, or Phoenix. Thanks to electronic speeds, the telephone customer is not inconvenienced by a detour of several hundred miles.

10 and 11.
There are many *different* kinds of telephones — (move to frame 11). Let's look at just a few. Would you recognize this as a telephone? It is — an *automatic reporting telephone*. It is usually placed in remote or unmanned locations and it sends recorded warnings of abnormal or dangerous conditions. With the proper sensing equipment, it can report fuel levels in distant tanks, changes of pressure in gas-filled containers, fires, power failures, and even burglaries.

12. This telephone is a *Bell System Data-Phone® Medical Set*. It is transmitting an electrocardiogram (ECG) from a heart-attack victim. The Data-Phone® Medical Set converts the ECG (electrocardiogram) signals into a signal which can be sent over regular telephone lines. In this way, a family doctor can get the advice of a distant heart specialist in just a few minutes.
13. This Data-Phone® set is used in the computer center of a large corporation to transmit business information. Video signals are also transmitted over this network. There is a good chance that your favorite national television show was sent to your local TV station through telephone system circuits.

    Written information is sent through the network by *teletypewriters*. News agencies, businesses, the police, and military all use teletypewriters. Finally, the network can transmit photographs, charts, and drawings.
14. Now let's look inside a typical *central office*. It has long aisles lined with racks of switching equipment. These racks of equipment are usually called "frames." The *frame* is the basic unit, or building block, of a switching device.
15. *Control panels* like this are used to monitor and control the switching devices. They take up most of the space.

    This next group of telephone equipment provides the *circuits* which *link* stations to switching centers and switching centers to each other.
16. *Circuits may include* wire or cable, coaxial cable, shortwave radio, microwave radio-relay systems, and transoceanic submarine cables. This overhead crane is moving cable in a Western Electric plant.
17. This is a *microwave relay tower*. Microwave stations transmit telephone traffic in the form of line-of-sight radio signals. These signals are focused into a *straight*, narrow beam — like a flashlight beam. A flashlight beam cannot bend around a corner and neither can the signals from this microwave tower. Mountain ranges could block the signals and, if relay towers were too far apart, the curvature of the earth might interfere with the signals.

    Microwave towers must be spaced regularly and take advantage of heights to

relay telephone signals from one to another.

Television signals are also line-of-sight signals, and this is why we need relay satellites to receive live television from overseas.

18. This map shows the *transoceanic cables* which link our telephone network with the telephone networks of other countries.

19. *Puzzle 1.* So the telephone network is something like a jigsaw puzzle. The three kinds of equipment — *stations, circuits,* and *switching centers* — must all fit together and work together.

20. *Puzzle 2.* For all its millions of pieces of equipment and billions of parts, this network must be considered as a *single entity,* or if you like, as one big machine. It is an entity which has been growing and evolving for nearly a century.

21. *Puzzle 3.* It would not be possible, let alone practical, to scrap all the existing equipment and start over fresh every time a new device or system is developed.

22. *Puzzle 4.* New equipment is phased-in and the previous equipment is phased-out gradually, with no interruption of service and at the lowest overall costs to the telephone customer. This means that *different generations* of equipment must be designed to work *together.*

23. *Puzzle 5. — Systems.* This ability of different kinds and ages of equipment to work together smoothly and without interference in the telephone network is usually called "compatibility." *Compatibility* is an important consideration in the design and manufacture of telephone equipment.

24. *Crossbar from Puzzle 5.* For example, telephone customers whose central office looks like this must be able to call people whose central office may look like the following:

25. *ESS Office from Puzzle 5.* This is one of the Bell System's new electronic *central offices.* This switching center uses solid-state electronic devices and computer-like control and memory systems to switch telephone calls in fractions of a second.

The telephone industry which stands behind this physical network is composed of many different companies. The Bell System operates about 85 million of the more than 100 million telephones and station devices in the United States.

26. The Bell System companies work closely together. *Bell Telephone* Laboratories perform research and design. *Western Electric* manufactures and installs telephone equipment for the system and the Bell Telephone companies provide telephone services to their customers. Research, design, manufacture and service all are coordinated. Research, for example, takes many forms.

27. *Research* may mean expanding scientific breakthroughs like the *laser,* which is already being used in telephone manufacture. It may mean pure research in fields like mathematics, physics, and chemistry. Or, it may mean applied research devoted to the successful design of new telephone equipment.

28. Telephone research has often yielded benefits which reached far beyond the telephone industry itself. Half a century ago, Western Electric's efforts to improve the *vacuum tube* for use as a telephone repeater led to radio, sound motion pictures, and television. Whole new industries were created as a by-product of telephone research.

29. In 1948, the discovery of the *transistor* effect by Bell Labs opened the door to the exciting new world of solid-state electronics. Again, whole new industries were created; computers and electronic data-processing could become practical realities.

After research comes manufacture. Manufacture, of course, begins with raw materials.

30. These *quartz crystals* are one of the newest raw materials created by man. They perform important electronic functions in telephone transmission equipment. Most natural quartz is imported; it is scarce and varies widely in quality. Furthermore, it is so expensive that it made good economic sense to invest in the process of "growing" these synthetic crystals.

31. Manufacturing equipment of the telephone network sometimes means using tiny components like this *resistor* in a glass capsule.

Many components in today's telephone equipment are so small that workers must view them through microscopes and handle them with delicate hypodermic-like tools.

32. After telephone equipment has been manufactured, it must be installed. These Western Electric *installers* set it up, connect it, and completely test it before turning the equipment over to the telephone company.

The telephone companies operate and service their own equipment.

33. These young ladies are *directory assistance operators*. Their efficient modern consoles enable them to assist more telephone customers than with previous equipment. This is just one way that improved equipment increases individual productivity.

34. This telephone company *installer* is responsible for putting telephone sets in customers' homes and offices. He is both electrician and carpenter. At times, when he must advise a housewife on the best spot for her telephone, he is even a bit of an interior decorator.

Telephone companies are usually the first to learn of the customer's needs and wants. They work to solve his communication problems and they prepare *forecasts* based on what they learn from the customer. In a sense they are the telephone customer's representative to the research and manufacturing part of the industry.

35. We have taken just a brief look at the telephone network. Many people don't realize that it exists. We have seen that it is made up of hardware and it is made up of people. The equipment must all work together if the network is to function properly, and so must the people.

In addition to the Bell companies, there are about *2,000 independent* telephone companies, many of which are combined into systems of their own. All the telephone companies, Bell and independent, are linked together through this telephone network.

Optional

There are many other companies that design or build telephone equipment. Still more companies make information processing equipment. The increasing ability of the telephone network to provide connections for their equipment is an example of new directions for telephone service.

36. Courtesy of Western Electric

Laboratory Activity (15)

Today's activity will help students understand the relationship of a single telephone or station to the overall system. They will learn about the large cables carrying many wires for the circuits.

1. Students will form in their groups of five. Each student will complete Problem 1 in the Laboratory Manual.
2. In Problem 2, two students will work with a piece of cable harness. The foreman of a group will be with one of his two pairs.
3. Allow time for students to answer six questions in the Laboratory Manual.

Homework

None

Note

In the next activity (optional), you are to use panels with phone components attached. If these are not available, plan to lengthen the filmstrip and/or begin cleanup which comes the day after.

Answers for Laboratory Manual

1. 6 wires.
2. 4 wires.
3. More wires would be needed.
4. 5 wires, or one-half of the wires.
5. Central control, automatically or manually, connects the telephones by switching the wires together.
6. There are 50 color combinations and 100 wires in a typical ¾" harness.

ASSIGNMENT 184, ACTIVITY 91B (OPTIONAL)

Story of the Telephone

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Using a component or subassembly of a telephone, describe some of the processes involved in the manufacture of the component or subassembly.
2. Using a disassembled telephone, identify the components and subassemblies, and identify some of the materials used to make the components.

Time Schedule

5 Overview
25 Presentation
15 Laboratory Activity

Equipment and Supplies for Presentation

Equipment

1 filmstrip projector/screen

Supplies

1 Filmstrip 184, *Manufacture of the Telephone*

Equipment and Supplies for Laboratory Activity

Supplies (Class)*

1 handset
1 Touch-Tone® assembly, push-button *or* dial, whichever is available
1 body shell
1 ringer
1 circuit package, base plate, switch assembly
1 package, container

*Components and subassemblies are available through local telephone companies.

Overview (5)

1. In the last class you saw the filmstrip *One Big Machine*. You examined a telephone harness and learned about stations, circuits, and switching centers, while comparing the old-fashioned system to a modern one.
2. Today's filmstrip will show you exactly how a Touch-Tone® phone is assembled from many components. It is about the same for a dial phone.
3. In the laboratory activity, you will examine telephone subassemblies and try to identify some of the *processes* used in their manufacture. You will also try to identify how many different *materials* are used in manufacturing the many components.

Presentation (25)

Script for Filmstrip No. 184 — 36 Frames

Frame No.

1. Focus
2. The World of Manufacturing
3. Industrial Arts Curriculum Project
   The Ohio State University
   Produced by
   McKnight & McKnight
   Publishing Company
   Bloomington, Illinois
4. *Manufacture of the Telephone*
5. The telephone is one of the most convenient and most important tools of our modern society. We use the telephone every day, but how much do we know about it? We may know that telephones are made in many types, colors, and models. This 12-button Touch-Tone® telephone uses push-button instead of a rotary dial, and it generates musical tones instead of dial pulses.
6. From the outside, this telephone looks fairly simple. If we take it all apart, we can see that the telephone is a very complicated piece of equipment. There are 752 separate parts which must all work together. These parts are combined into several groups, or subassemblies, such as the *ringer*, the *switch assembly*, the *circuit package*, and the *handset*. Each subassembly is made and tested on its *own assembly line* in the factory. Then it is sent to a final assembly line where telephone sets are put together, tested, and packaged for shipping. We will look at each important subassembly in turn.

Most of the 752 parts are made in this same factory — by *molding, die-casting, stamping,* or *other processes* of *shaping* and *forming.* Let's begin by looking at the telephone case, which is made of plastic.

7. These *plastic pellets or granules* are made into telephone cases, called *housings,* and into handles and the caps which go on either end of the handle. The process is called *injection molding.* Boxes of plastic are stored in a basement directly under the molding area. The temperature and humidity are carefully controlled. The granules are fed up to the injection-molding presses by pneumatic tubes.
8. *Telephone handles* are made, six at a time, in this press. The handles are trimmed and inspected.
9. Then they are sent by conveyor to this machine where the *hole* for the telephone cord . . .
10. . . . is drilled, reamed, and chamfered. The *handles* are *buffed and polished* by automatic buffers. After passing inspection, each handle is wrapped in a plastic sleeve to protect it, and sent to the *handset assembly line.* The telephone housings are made in injection-molding presses. The housings are stacked on pallets, buffed and polished, and then placed in temporary storage.
11. When a telephone of a particular color is to be produced, the specified *color housings* are sent directly to the final assembly line by conveyor. Other plastic parts, like these buttons for the Touch-Tone® dial, are also made at the Indianapolis factory.
12. Now let's look at the first subassembly, the *circuit package,* which has 139 parts. The circuit package contains electronic components: an induction coil, capacitors, resistors, and varistors. These components work together to control the quality and strength of the signals *to* and *from* the telephone set. For example, the circuit package adjusts the signal strength according to the loudness of a speaker's voice and the distance from his telephone to the central office. One important component in the circuit package is the induction coil, which is the bright copper coil in the upper left of the picture. This coil transforms "talking" current, which arrives as pulsating *direct* current, into *alternating* current for the receiver.
13. The *induction coils* are made on coil-wind machines. The coils are wrapped with alternate layers of copper wire and plastic insulating material. The coils are wound 13 to the stick, and cut apart at another working position. A single machine makes the brackets for the coil and the capacitors by punching and bending a metal strip. It then inserts the brackets into a plastic terminal board, puts the coil into its bracket, and finally crimps the bracket tight.
14. The other electronic components are added to the terminal board, and the connections are soldered.
15. The complete *circuit package* looks like this.

    The circuit package is then sealed in a metal can, called a *pot,* to protect it. After potting, the circuit packages are electronically tested. Electronic units which pass are sent to final assembly.
16. Now that we have seen how the circuit package is made, let's look at the next subassembly, the ringer. This unit rings our telephone bell so that we know when someone is calling.

    You may recognize another *coil* among the 85 parts of the ringer. It's at the extreme left. This is an electromagnet which causes the clapper to vibrate back and forth between the two bells.
17. Assembly begins with cast metal parts which are *fastened* together by a press to form the frame of the ringer.
18. Additional parts are added to the *frame,* and then the *bell* is attached. Power tools are used here, and throughout the assembly of the telephone set. The *ringer is tested* and, if need be, adjusted before it is sent to final assembly.
19. The completed *ringer* looks like this.
20. The next subassembly is the *Touch-Tone® dial.* The dial, with its 330 parts, is the most complicated subassembly of the Touch-Tone® telephone. It has two working sections: a *mechanical* section and an *electronic* section.
21. The *mechanical section* on the left contains the push-buttons. The *electronic* section on the right generates the musical tones that are used for signalling.

The two sections fit back-to-back on the completed dial.

22. The mechanical half of the dial begins with a square dial plate. The buttons are inserted in the proper order. Coil springs are added, together with other small plastic and metal parts. When all the mechanical parts of the *push-button assembly* are attached, a metal plate is fastened to the back of the dial so it holds all the mechanical parts firmly in place.
23. The electronic half of the dial was put together on a different assembly line. It is fastened to the other side of the metal plate on the dial, and various connections are then soldered. The different wires used in this subassembly and *other* parts of the telephone are color coded and precut. The eyes are already attached. This speeds up wiring work throughout the assembly process.
24. The completed Touch Tone® dial is first visually *inspected* for loose connections, faulty soldering, and other physical defects. Then it is electronically tested for all its functions before it is sent to the final assembly line.
25. The next subassembly is the *handset*. It contains the receiver and transmitter. The receiver changes incoming electrical signals into sounds which you can hear and understand. The transmitter changes the sound of your voice into electrical signals which can travel over the telephone line.
26. The *plastic handles* are delivered to the handset assembly line. First, the telephone *cord* is inserted into the handle.
27. Then, *wire leads are connected to the receiver* and transmitter and both are inserted into the handle.
28. *Plastic caps* are screwed tightly onto the handle to hold the receiver and transmitter in place. Then the completed handset is electronically *tested* on this console before it is sent to final assembly.
29. We won't take the time to describe how the *switch assembly* is made. It is one of the smaller subassemblies and is put together by processes which we have already seen used on other parts.

    The *switch assembly* is operated by the two little buttons which pop up when you raise the handset. They cause the switch assembly to stop the ringer and to close a circuit so you can talk with the person on the other end. When you "hang up the phone" or put the handset back down in its cradle, the switch assembly opens the circuit. Then the telephone is ready to accept another call.
30. Now let's go straight to the *final assembly*. All of the completed sections of the telephone flow together on the final assembly line. They come, for the most part, by conveyor from their individual assembly lines. Some parts are delivered in bins. The telephone housings come from temporary storage. The telephone wire, which is made at another Western Electric factory, comes from a storeroom.

    Final assembly begins with a *metal base plate*. The rubber feet are fastened onto the bottom of the base plate and then each subassembly is added in its turn. First, the switch assembly is mounted.
31. Then, the *circuit package* in its metal pot is riveted onto the base plate.
32. At the next position down the line, the *ringer* is attached to the base plate and the leads are connected from the ringer to the circuit package.

    Then the base plate goes to the last operator on the line. He checks it, stamps the model number on the bottom, and puts it into an overhead conveyor.

    The overhead conveyor delivers the base plate to the next workline where an operator places it on a flat bench conveyor with the dial, handset, and phone wire.
33. As the set moves down the conveyor line the *telephone wire* is connected to the circuit package.
34. The *Touch-Tone® dial* is attached to the telephone set and connected.

    The telephone *housing* is placed over the set and screwed firmly to the base plate.

    Before the finished telephone leaves the assembly line, it is given a final electronic *testing*.
35. Then the telephone is *packed* in a carton and sent by conveyor to the merchandise area. Each telephone model has a distinctive *package design*. A reflectorized metal tag on the box guides it through the automated conveyor system.

    In the *merchandise area*, the individu-

ally boxed telephones are packed in shipping cartons. Among other innovations, closed circuit television is used to supervise shipping operations.

Finally, the cartons of telephones are loaded by a *forklift* truck . . . into a truck which will start them on their way to Bell System *customers* across the United States.

36. Courtesy of Western Electric Company

Laboratory Activity (15)

Today, students will try to identify some *manufacturing processes* and *materials* used in the manufacture of components and subassemblies of a telephone.

1. Distribute *one* telephone display board to *each* group of five students.
2. Allow students time to determine how their selected component or subassembly was manufactured and what materials were used to make all the components on the board. Students are to *answer the questions* in their Laboratory Manuals.
3. Have the spokesman for each group describe the manufacture of their part to the rest of the class.

Homework

None

Note

1. A dial phone may be used in place of the Touch-Tone® phone.
2. If no phone is available, you may:
   a. Lengthen the time to present the filmstrip.
   b. Investigate the wire harness of ACTIVITY 90A some more.
   c. Show an old or antique phone to class, if available, and compare to modern phone.
   d. Use "The Telephone Story" Chart in ACTIVITY 90 from Bell Telephone Company. Point out use of wood in old phones, when plastic was first used, the run of black phones before colors were developed in plastic, etc.

Answers for Laboratory Manual

Group 1

1. Mouthpiece cap
2. Component
3. Forming
5. Casting-molding

Material list varies.

Group 2

1. Dial plate
2. Subassembly
4. Mechanical fastening, coating
7. 3
8. Key plate *or* station number window *or* coating

3, 5, 6. Answers will vary.

Group 3

1. Body shell
2. Component
3. Forming
5. Casting or Molding

Material list varies.

Group 4

1. Brass bells
2. Component
3. Forming and separating
5. Compressing and stretching (drawing)
6. Shearing, blanking, or punching

Material list varies.

Group 5

1. Base plate
2. Component
3. Forming and separating
5. Compressing or stretching (drawing)
6. Shearing — blanking or punching

Material list varies.

Group 6

1. Package
2. Subassembly
4. Coating and bonding
7. 3-box, printing, and sticker
8. Box *or* printer *or* sticker
3. Forming *or* separating
5. Answer will vary.
6. Answer will vary.

Material list varies.

ASSIGNMENT 185 (OPTIONAL)

Cleanup

Objectives

As a result of their learning experiences, the students should be able to do the following:

Laboratory Activity

1. Exemplify the postprocessing concept of *maintaining* by performing clean-up duties throughout the laboratory.

Time Schedule

40 Laboratory Activity
5 Comments

Equipment and Supplies for Laboratory Activity

Equipment

buckets
mops
brushes
scrapers

Supplies

rags
lubricating oil
sponges
detergents

Laboratory Activity (40)

Maintaining a laboratory is a major part of *postprocessing* or *servicing*. Today the class will clean the laboratory and prepare it for next fall.

1. Students work in their groups of five. Appoint one of the five as the *manager*, the other four as *maintenance* workers.
2. Assign each group a task: oil tools, stack materials, clean machines and benches, clean floor areas, clean out lockers, store teaching aids, etc.
3. Proceed with the cleanup.
4. Replace all equipment and supplies after 40 minutes.

Comments (5)

1. Thank the students for cleaning the laboratory, oiling and greasing tools and machines, and storing materials for the class next year.
2. We hope that students have found the study of the man-made world exciting and educational and just as important as the study of the natural world in other school subjects.

Appendix A
Teaching Aids and Special Equipment

Transparencies

Supplied by McKnight & McKnight Publishing Company. (Number corresponds to assignment number. Figures in parenthesis indicate a series.)

18	56 (1-3)	87	144 (1-2)
19	58 (1-4)	100	145 (1-2)
20	64	101	146 (1-2)
26 (1-3)	70 (1-2)	108 (1-4)	147
28	71	114 (1-5)	148
40	72	126	152 (1-4)
44	73 (1-3)	135	153 (1-3)
45	76 (1-7)	139 (1-3)	175
50	83 (1-6)	141	180 (1-6)
55	86 (1-5)	143 (1-2)	

Filmstrips

Supplied by McKnight & McKnight Publishing Company. (Assignment number and title.)

3	Introduction to the World of Manufacturing
50	Employment and Occupations in Manufacturing
62	Securing Inputs to Manufacturing
94	Raw Materials, Standard Stock, Components, Subassembly, Assembly, Finished Product
95	Forming Processes
96	Casting or Molding
103	Conditioning Material
105	Making Assemblies or Finished Products
109	Shearing
112	Chip Removing
115	Separating by Other Processes
141	Corporations and Their Trademarks
142	Overview of Manufacturing Corporation
177	Manufacturing in the Future
181	Story of Tires
183	The One Big Machine
184	Manufacture of the Telephone

Achievement Tests

Supplied by McKnight & McKnight Publishing Company. (Assignment number and test number.)

25. 1	75. 4	118. 7	179. Comprehensive
49. 2	90. 5	138. 8	
60. 3	107. 6	156. 9	

Charts

Supplied by McKnight & McKnight Publishing Company.

Quantity	Title and Item Number	Assignment
1	Class Organization Chart No. 3	3
1	Production Process Chart No. 93-1	93
2	Product Illustration Sheets No. 93-2	93
1	Manufacturing Corporation Plant Layout Chart No. 143	143
150	One Dollar Certificates No. 144	144
128	Stock Certificates No. 144	144
1 set	Instructional Panels (for line production of high-intensity lamps) Nos. 149-1 to 149-11	149
1	Production Process Flowchart No. 153-1	153
1	Production Sequence for Activity 81, Chart No. 153-2	153
1	Telephone Story Chart No. 183	183

Special Items (Minimum quantities)

Per Teacher (Per 5 Classes, 25 Students Per Class)	Item	Assignment
	COAT HANGER FIXTURE SET	
4	Bending & twisting fixtures No. 7-1	7
4	Bending & twisting fixtures No. 7-2	7
2	Bending & twisting fixtures No. 7-3	7
2	Bending & twisting fixtures No. 7-4	7
2	Hanger neck gage No. 7-5	7
2	Template for hanger No. 7-6	7
15	Fin assembly fixtures No. 10	10, 11
1 set	Start and finish gate set	16
5 sets	Big Manufacturer Game	24, 48, 59, 74, 89
1	Salt drilling jig No. 41-1 (3/32" holes)	41, 42, 43
1	Pepper drilling jig No. 41-2 (1/16" holes)	41, 42, 43
1	Screen sieve set	87, 88
5	Draw die fixtures	95
10	Brick molds	96
2	Vacuum-forming boxes	100
5	Compression-molding kits	100
1	Rivet jig	101
1	Screwdriver handle drilling fixture	105
3	Die cutter jigs	109
1	Electrical discharge machine	115
5	Glass cutting jigs No. 116-1 (teacher made)	116
1	*Glass cutting jig fixture No. 116-2	116
	HOLDING JIGS	
1	Guide A, marking, for jig No. 121-1	121
1	Guide B, drilling, for jig No. 121-1	121

* Teacher-made.

Per Teacher (Per 5 Classes, 25 Students Per Class)	Item	Assignment
1	Drill jig for mallet head No. 121-2	121
1	Tapping jig for mallet head, No. 121-3	121
1	Drill jig for mallet tips, No. 121-4	121
1	Tapping jig for mallet tips, No. 121-5	121
1	Hinge marking, cutting jig, and fixture, No. 126-3	126
15	Circuit board kits, w/o batteries No. 136-1	136
15	Continuity testers, w/o batteries, No. 136-2	136
2	Drilling fixtures for lamp parts, No. 149-1	149
1	Hanger bracket template, No. 149-2	149
2	Drilling jigs for hanger bracket and lamp stem, No. 149-3	149
1	Bending fixture for hanger bracket, No. 149-4	149
1	Drilling jig for shade, No. 149-5	149
1	Saw jig for stem, No. 150-1	150
1	Squeegee fixture for stem, No. 150-2	150
1	Stem drilling jig, No. 150-3	150
1	Stem bending fixture, No. 150-4	150
5	*Shade top go-no-go gages, No. 154-2	154
5	*Base bottom go-no-go gages, No. 154-3	154
1	*Tape cutting jig for package, No. 169-1	169

* Teacher-made.

Appendix B
List of Equipment for Students

(Supplied by School)

Measuring Tools

Per Teacher	Item	Assignment First Used
10	36″ bench rules *or* yardsticks	6
25	12″ rules	8
1	6′ steel tape	17
10	French curves	20
5	Inside calipers	26
5	Outside calipers	26
1	Stopwatch	30, 35, 36
5	Protractors	37
5	30° - 60° triangles	37
4	6″ try squares	41, 42
1	6″ depth gage	41, 42
5	Pencil compasses w/pencils	51
1	Wire gage	70
1	Drill gage	70
1	1″ micrometer	70
5	Measuring cups, 1 qt. size	96
5	Plastic buckets, 5 qt. size	96
1	Vacuum tube voltmeter *or* volt ohmmeter	136
5	24″ rules	169

Power and Heavy Equipment

Per Teacher	Item	Assignment First Used
1	Belt *or* disc pedestal sander	12, 13
1	Drill press	14, 15
1	3/8″ portable electric drill	14, 15
1	Bandsaw *or* jig saw	31 - 34
1	Box and pan brake (24″ min.)	31 - 34
1	Circular table saw	31 - 34
1	Floor shear *or* squaring shear (24″ min.)	31 - 34
1	Orbital sander	41, 42
1	Slip roll	91A
1	Spirit duplicating machine	140
1	Bar folder	149

Metal Working Tools

Per Teacher	Item	Assignment First Used
5 pr.	4″ or 6″ standard diagonal pliers	6
10	6″ combination *or* slip joint pliers	6
2	8″ double cut files	6
5	8″ or 10″ mill file (medium cut)	12, 13
5	6″ scriber (awl)	12, 13

Per Teacher	Item	Assignment First Used
5	4″ center punches	14, 15
5	Tin snips	14, 15
5	8 oz. ball peen hammers	14, 15
3	#6-32 threading dies	14, 15
3	1″ die stocks	14, 15
5	Aviation snips, cuts straight 10″ long	14, 15
1	Mallet rubber, 20 oz., 3¾″ x 2½″ head	95
8	C-clamp, 0″ - 4″ capacity	95
1	Anvil, 100 lbs.	101
1	Metalworking vise, 3½″ jaw width	101
10 pr.	Vise grip wrenches, 1⅛″ jaw adjustment	101
3	Handy spring clamp, 2″ opening	105
5	Countersinks ¼″ shank, ½″ cutting edge	108
25	X-acto® knives	108
10	Mill files, smooth 10″	108
5	Hand drills	108
6	Screwdrivers w/plastic handles, 4″ to 6″	115
5	Glass cutters	116
5	Hacksaw frames, adjustable 10″ or 12″	120
5 pr.	8″ combination pliers, 1½″ capacity	121
1	Jorgenson adjustable hand screw clamp, No. 0	121
2	10″ bastard mill files	121
1	File cleaner	121
1	Taper pin reamer, No. 2 or No. 9	121
1	Tap wrench	121
1	Bottom tap, ¼″-20	121
5	Vise jaw guards	121
5	6″ adjustable wrenches	124
1	Handy seamer	124
5 pr.	Coax cutters and wire strippers	133
1 pr.	Flatnose pliers	149
2	Pop rivet guns, ⅛″	149
1	Metal punch, Whitney Jr.® No. 5	149
2	Utility knives	157
1	10″ round file	157

Woodworking Tools

Per Teacher	Item	Assignment First Used
15	Coping saws	10, 11
1	Miter box w/saw	14, 15
5	½ round wood rasps	31 - 34
5	½ round cabinet files	31 - 34
5	Crosscut handsaws	41, 42
2	Hand braces	41, 42
5	7 oz. claw hammers	51
10	Pointing trowels	96
5	Woodworking vises	157
1	File card	

Foundry Tools and Equipment

Per Teacher	Item	Assignment First Used
5	Propane torch w/utility burner and flame spreader	87
5	Spark lighters	87
5	Tripod ring stand w/screen	87
5	5″ melting ladles	91A
5	Striking bars, ½″ x ½″ x 12″ square or angle cold-rolled steel	91A
5	Skimmers	91A
5	Bench rammers, size 3½″ x 14″	91A
5	Foundry screens or riddles, 8 or 16 mesh to the inch	91A
5	Asbestos gloves, unlined, 14″ long	98
5	Molders finishing trowels	98
5	Foundry flasks, 6″ x 8″ w/3″ cope and 3″ drag	98
5	Molding boards, 8″ x 10″	98
5	Bottom boards, 8″ x 10″	98
5	Spoon and gate cutters, 2″ x 3″ tin plate, bent in U-shape	98
1	Molders bellow, 8″	98
5 pr.	Tweezers, 4½″ long, curved point	98
5	Rapping pins, ½″ x 6″ mild steel rod	98
100 lbs.	Molding sand, petro bond	98
½ lb.	Parting compound	98
5 pc.	Dropcloth, heavy plastic, 4′ x 4′	98
1	Crucible or bench furnace	98
1 pr.	Crucible tongs	98
2	Safety eye-shields	98
1	Skimmer	98

Drills (High Speed Steel)

Per Teacher	Item	Assignment First Used
5	#40 Drills	
5	¼″ twist drills	14, 15
5	⅛″ twist drills	14, 15
2	5/16″ twist drills	51
5	3/16″ twist drills	14, 15
1	1/16″ twist drill	10, 11
1	3/32″ twist drill	41, 42
1	5/64″ twist drill	14, 15
5	7/64″ twist drills	22
1	½″ auger bit	41, 42
1	¾″ auger bit	41, 42
1	1″ Forstner bit	51
1	¾″ spade bit	31 - 34
1	¾″ Forstner bit or spade bit	31 - 34
1	½″ Forstner bit or spade bit	41, 42
1	½″ drill	121
2	⅝″ drills with ⅜″ or ½″ shank	149
1	5/32″ drill	149
2	13/32″ drill	149
1	9/64″ drill	120
1	11/64″ drill	126
1	13/64″ drill	121

General Tools and Equipment

Per Teacher	Item	Assignment First Used
5	Bench knives	4
5	Buckets (10 gal. plastic buckets for clay storage)	4
5	Modeling tools (for clay)	5
5	Rolling pins *or* 2″ dia. x 12″ pipe (for clay)	5
1	Paper punch, single hole	6
20 pr.	6″ pointed scissors	6
25	X-acto® knives *or* equivalent	10, 11
25 pr.	Safety glasses	14, 15
10	½″ paintbrushes	22
25	Artist's paintbrushes (assorted sizes)	22
1	Polaroid camera w/4 pack films (optional)	37
5	Desk staplers	37
5	Plastic tote trays	84
5	Eggbeaters	88
1	Electric flatiron *or* 1 photo print dryer	88
5	6″ hand rollers *or* equivalent brayers	88
5	Metal bristle brushes *or* dog combs	91B
20	Pocket combs	91B
5	6″ bar magnets	92A
1	Vacuum sweeper w/hose	100
2	Infrared heat lamps, 250 watts	100
2	Floodlight sockets, outdoor, mounted on upright stand	100
4	Bulldog clips, No. 3, 2½″	100
1	Test tube rack, 25 holes (one hole per student)	103
5	Silk screen frames, 12″ x 12″	111
1	Rubber squeegee	111
1	Cardboard box, 10″ x 15″ x 20″	114
50	Sanding blocks, ¾″ x 2″ x 2″	116
1	Paste brush	120
1	Paper stapler, 5″ throat or larger	125
1	Template, No. 126-1	126
1	Template, No. 126-2	126
1	Drill fixture, No. 126-3 (teacher made)	126
1	Locating and cutting die, No. 126-4	126
5	Service manuals, variety	136
30	"D" cell batteries	136
15	Penlight cell "AA" batteries	136
45	Bulbs to match sockets for circuit board kit No. 136 (teacher-made)	136
1	Rubber stamp pad	139
1 set	1″ cardboard letters	139
1	Padding brush	139
1	Paper cutter, 15″	140
4	Temporary drill fixtures	149
1	Tape writer	157
1	Template for top	157
1	Template for bottom	157
5	Postal scale, ½ oz. increments, 16 oz. capacity	8, 9
30	Small culture tubes, 20 ml. x 150 ml.	182
2	25 W or 40 W light bulbs	182

Chemistry Equipment

Per Teacher	Item	Assignment First Used
5	3″ dia., 2 oz. plastic funnel	84, 92
5	8 oz. measuring cups (plastic)	84
1	18″ x 3/8″ dia. polyethylene tubing	84
10	1000 ml. glass beakers (flat bottom, boiling flask)	87
2	Glass rods, 1/4″ dia. x 6″	87
1	5′ flexible tubing (for siphon) 1/4″ I.D.	87
1	3″ glass tubing, 1/4″ O.D.	87
2	8 oz. Owens oval bottles *or* common narrow-neck 8 oz. bottles	87
1	Rubber stopper for 1000 ml. flask with 1/4″ tube hole	87
5	16 oz. measuring cups (plastic)	87
5	Tablespoons	88
2	100 ml. glass beakers	92A
1	200 ml. full-form beaker, 2 1/4″ I.D.	92A
1	100 ml. volumetric pipette w/rubber bulb	92A
1	Ring stand to support tall beaker	92B
5 pr.	Rubber gloves	92B

Appendix C
List of Expendable Supplies

Materials are supplied by the school. Quantities are based on 25 students per class and five classes per teacher. The list of expendable supplies has been divided into two major categories in this appendix. Study the "General Supplies" for items used many times during this course and study the "Supplies for Specific Products" for special activity needs.

General Supplies

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
5	5	Sponges, 1½″ x 3″ x 6″ (approx.)	4
5	5	Tin cans (for water)	4
		Paper towels	4
10	10	¼″ x ¾″ x 12″ common lumber	5
5	5	Coat hangers	6
2	2	½″ I.D. x 5½″ pipe	6
3 reams	1 ream	8½″ x 11″ white paper, #20	8, 9
5 rolls	1 roll	¾″ masking tape	8, 9
5 btls.	5 btls.	White glue	8, 9
125	25	2H pencils	10, 11
25 shts.	25 shts.	Abrasive paper (fine)	10, 11
5	5	Transparency marking pens (assorted colors)	18
1	1	Grease pencil	19
50	10	File folders (manila)	19
1 box	1 box	Colored pencils *or* crayons	19
5	5	Felt tip markers (assorted colors)	19
45	15	Ball point pens	19
25	25	Erasers	20
1 ream	¼ ream	8½″ x 11″ duplicating paper	20
150 shts.	30 shts.	8½″ x 14″ carbon paper	21
1 ream	¼ ream	8½″ x 11″ cardstock	22
1 pack	1 pack	3″ x 5″ cards (eraser shields)	25
5	5	⅝″ I.D. washers	26
5	5	¾″ I.D. washers	26
5	5	⅞″ I.D. washers	26
5	5	1″ I.D. washers	26
5	5	¾″ x 12″ dowels	26
2 boxes	1 box	Paper clips	28
1 ream	¼ ream	8½″ x 14″ tracing paper (unlined)	28
3 reams	¼ ream	8½″ x 11″ tracing paper	30
25 shts.	25 shts.	8½″ x 11″ carbon paper	31 - 34
3 boxes	1 box	Thumbtacks	31 - 34
50 shts.	25 shts.	Abrasive paper (medium)	41, 42
25 shts.	25 shts.	Abrasive paper (course)	41, 42
2 shts.	1 sht.	80-grit abrasive paper for belt *or* pedestal sander	41, 42
5 shts.	1 sht.	120-grit abrasive paper for orbital sander	41, 42
5 sets	5 sets	Epoxy glue	
2	1	1½″ finishing paintbrushes	41, 42
5 rolls	1 roll	Transparent tape	46
5	5	Different equipment and supply catalogs; e.g. Brodhead-Garrett, Paxton, Midwest, Sears, etc.	47

364

General Supplies (continued)

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
10	10	Employment ads from newspapers	50
5 btls.	1 btl.	Rubber cement	51
10	2	Shoe boxes	55
1	1	Cutout: Gas Serves Your Community (from your local natural gas company)	84
5 oz.	5 oz.	Iron filings	87
5 lb.	5 lb.	Sand	87
130	30	Plastic bags (sandwich size)	87
5	5	Filter paper, 5″ or 6″ dia.	87
1 btl.	1 btl.	Liquid starch	88
15 boxes	3 boxes	Non-wet strength tissues (180 per box)	88
25 btls.	5 btls.	Food coloring	88
40	40	6d common nails	91A
15	15	Bricks	91A
5	5	12″ x 12″ Transite *or* equivalent	91A
1	1	12″ x 24″ Transite *or* equivalent	91A
50 lbs.	25 lbs.	Pig lead	91A
50 lbs.	25 lbs.	Molding sand	91A
5 lbs.	1 lb.	Non-silica parting compound *or* talcum	91A
5	5	Mold patterns (25-pica printing slugs or equivalent)	91A
10	10	½″ x 2″ x 12″ common lumber	91A
1 sht.	1 sht.	½″ x 4′ x 4′ plywood	91A
5	5	5″ cardboard mailing tube *or* ¾″ dowel	91B
5	5	Shallow container (metal baking pan approx. 1½″ x 10″ x 10″)	91B
125	25	Cotton balls (*or* bolls)	91B
2 gals.	5 pts.	Cleaning solution (mineral spirits *or* paint thinner)	91B
5	5	10W oil in qt. cans	92A
1 ball	1 ball	String	92A
		Newspapers	
25 pcs.	5 pcs.	4″ x 4″ cardboard	92A
25 qts.	5 qts.	Contaminated oil, 10W	92B
5 sq. ft.	1 sq. ft.	Aluminum foil, 36 ga. soft	95
250 ea.	250	Paper clips, 3 oz.	95
250 ea.	250	Wooden sticks for stirring	95
½ bag		Portland cement	96
1 bag		Sand	96
4 pcs.	4 pcs.	Tempered cover boards, ¼″ x 5″ x 10″	96
125 pcs.	25 pcs.	Styrene plastic sheeting, .020 ga., 6″ x 6″ for vacuum forming	100
5 cups	1 cup	Wood chips, fine	100
2 pcs.	2 pcs.	Aluminum or copper sheet, any ga., 4″ x 6″	104
1 can	1 can	Quenching oil	104
40 yds.	4 yds.	Contact vinyl, or wood grain solid pattern, 18″ wide	109
2 sq. ft.	2 sq. ft.	Stencil film, lacquer base	110
1 roll	1 roll	Waxed paper, 25′ x 12″	110
45 cans		Quick drying aerosol spray enamel, 16 oz., assorted colors	111

General Supplies (continued)

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
3 qts.	3 qts.	Silk screen ink, fast drying	111
1 gal.		Rubber cement	111
1 qt.		Rubber cement thinner	111
1 qt.	1 qt.	EDM dielectric electrolyte solution (Texaco 499 EDM)	115
5 pcs.	5 pcs.	Aluminum, .032 ga. x 1″ x 2″	115
35 shts.	6 shts.	Silicon carbide paper, wet-dry, medium grit	116
50 pcs.	50 pcs.	Plate glass, single strength, 3″ x 12″	116
5 tubes	5 tubes	Glass etching cream, 1½ oz. size	116
1	1	Solder brush	119
3 pcs.	3 pcs.	Galvanized iron, 28 ga., 4″ x 4″	121
1 ft.	1 ft.	Solder wire, acid core	121
1 btl.		Soldering flux	121
1 pc.		Transite	121
4 pcs.	4 pcs.	Sheet plastic, 5⅞″ x 4″ (Saran Wrap)	121
2 cans	2 cans	Rubberized vinyl, 13 oz.	123
22 lbs.	22 lbs.	Prepolymer A and catalyst B, flexible polyurethane foam components	125
2 shts.	2 shts.	Aluminum oxide abrasive paper, 120 grit	126
2 sq. ft.	2 sq. ft.	Polyethylene, .060″ x ½″ x 5″ for hinges	126 - 132
5	5	Paper box *or* paper bag	133

Provide the Following or Equal-Type Packages for Assignment 134:

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
1	1	Frozen food bag *or* carton	134
1	1	Glass jar, screw-off type lid	134
1	1	Candy bar, wrapped	134
1	1	Cutaway carton, e.g., Head and Shoulders Shampoo® in a tube	134
1 box	1 box	Powdered soap or detergent	134
1	1	Silica gel package	134
1	1	Egg carton	134
1	1	Cola case, 6-pack carton	134
1	1	Plastic bag or mesh bag, fresh vegetable type	134
2	2	Milk cartons, ½ gal. size	134
1	1	Razor blades, blister packed	134
2 boxes	2 boxes	Toothpaste, deodorant, etc. type	134
1 box	1 box	Cereal or other foodstuff	134
5 pcs.		Inner tube or rubber gasket, 1/16″ *or* ⅛″ x 2″	139
250 pcs.		Plain white cards, 3″ x 5″	139
26	26	Spirit masters	140
1 can	1 can	Spirit duplicating fluid	140
1 jar	1 jar	Hand cleaner for removing spirit duplicating ink	140
500 shts.		Duplicating paper, 8½″ x 11″	140
360 shts.	212 shts.	White paper #20, 8½″ x 11″	142
10 lbs.	10 lbs.	Rags	143
5		Lamp base bottom, flat metal inspection template (teacher-made)	154

General Supplies (continued)

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
5		Shade top, flat metal inspection template (teacher-made)	154
1 pc.	1 pc.	12″ x 12″ peg board, ¼″ dia. holes	157
5 bxs.	1 box	Paper clips	157
5 pkg.	1 pkg.	Steel wool	157
5 qts.	1 qt.	Vinegar, 5% acidity	157
1		Whitewall tire, discarded	181
50	10	Paper cups, 12 oz.	182
50	10	Cup lids, snap-on *or* 6″ x 6″ piece of plastic film	182
1 can		Talcum powder	182
10		¾″ telephone multiwire cable harness, approx. 2′ long	183
1	1	*Telephone headset	183
1	1	*Touch-Tone® assembly push-button on dial	184
1	1	*Telephone body shell	184
1	1	*Telephone ringer	184
1	1	*Telephone ringer circuit; package base plate, and switch assembly	184
1	1	*Telephone package *or* container	184

*Optional items obtained from the telephone company.

Supplies for Specific Products

Supplies are listed according to the product. Therefore, some items may appear twice. General supplies such as paper, tape, etc. are listed under General Supplies.

Per Teacher (5 classes)	Per Class (25 students)	Item
Clay Products, Assignments 4, 5		
125	25	Tongue depressors
5	5	6′ x 8′ plastic dropcloth *or* oilcloth
125 lb.	125 lb.	Amoco No. 27 white sculpture clay, de-aired, moist, in 25 lb. or 100 lb. lots *or* equivalent
Coat Hanger, Assignments 6, 7		
15 shts.	3 shts.	22½″ x 34″ chipboard (.030 caliper)
1000′	200′	⅛″ dia. x 4′ lengths half-hard aluminum wire (1100 H19)
Model Rocket Fabrication, Assignments 8-15		
5 rolls	5 rolls	3″ gummed paper tape
10	10	1″ dia. x 12″ dowel rod (lacquered)
125	25	No. 12 corks
125	25	1″ dia. x ½″ dowel
125	25	No. 8 corks
50	10	3/16″ x 10½″ paper-waxed soda straws
10 tubes	5 tubes	Household cement (butyl acetate), quick drying

Supplies for Specific Products (cont.)

Per Teacher (5 classes)	Per Class (25 students)	Item
30 shts.	6 shts.	3/32″ x 12″ x 14″ binders board *or* heavy cardboard
125 pcs.	25 pcs.	.001 x 12″ x 14″ polyethylene fiber sheet (dry cleaning bag)
3 spl.	1 spl.	72 yd. shroud line (Estes 651-SLT-1 *or* equivalent)
125	25	Screw eyes 3/4″ long *or* staples
125	25	1/8″ x 18″ airplane contest rubber (Estes 671-SC-1 *or* equivalent). See Assignment 12, 13, Fig. 12-1.
25	5	1/4″ x 6″ dowel
75′	15′	No. 18 soft iron wire *or* coat hangers
1 gal.	2 qt.	Enamel thinner
1 gal.	2 qt.	Enamel, assorted colors
10 cans	5 cans	Spray enamel, assorted colors
5	5	Postal scales, 16 oz. x 1/2 oz. See CO_2 LSRAV Supplies

Rocket Firing (if rocket is fired)

1	1	Launch control system (Estes 651-FS-5 *or* equivalent)
1	1	6 volt battery (Eveready No. 731 *or* equivalent). 12 volt car battery is excellent.
1	1	Estes Educational Packet with No. 691 catalog
10	2	A 5-2 model rocket engines (for teacher demonstration only; student quantities not included)
1 pkg.	1 pkg.	Recovery wadding (Estes 651-RP-1A *or* equivalent)
10	2	Rocket engine igniters (teacher demonstration only)
1	1	1/8″ x 36″ copper-coated mild steel welding rod

Engine Mounts (if rocket is fired.)

5	1	1″ x 6″ heavy paper
5	1	5/8″ dia. x 3″ dowel
5	1	1/8″ x 1/8″ x 50″ lightweight softwood
5′	1′	1″ dia. x 7 1/2″ dowel
5	1	0.710 inside dia. x 18″ paper tube (Estes 651-BY-20 *or* equivalent)

Altitude Scopes (if rocket is fired.)

5 shts.	1 sht.	7″ x 7″ cardboard
5	1	1/2″ x 1″ x 6 1/2″ softwood
5	1	28 gage, 2 1/2″ x 6″ galvanized iron
5	1	6-32 x 1″ RH machine screw
5	1	6-32 hex nuts
5	1	6-32 wing nuts
5	1	1/2″ dia. x 8″ dowel

368

Supplies for Specific Products (cont.)

Per Teacher (5 classes)	Per Class (25 students)	Item
Launch Platform (if rocket is fired.)		
5	1	28 gage, 6″ x 6″ galvanized iron
15	3	1/8″ x 1″ FH machine screw w/nuts
5	1	1/8″ x 24″ welding rod
10	2	6-32 hex nuts
5	1	3/4″ wood cubes with 1/8″ hole drilled half-way through
5	1	6″ x 6″ heavy cardboard
CO_2 Land Speed Record Assault Vehicle, Assignments 16-37		
1	1	1/8″ x 4′ x 8′ hardboard (for test track)
1	1	2″ x 6″ x 48″ (approx.) pine *or* fir (for test track)
65′	13′	1/8″ dia. x 6″ brazing rod *or* welding rod
4′	1′	.138 I.D. x 5/32″ O.D. 1/2″ long nylon tube *or* hose
500	100	No. 6 brass washers
150	30	3/4″ x 2″ (approx.) CO_2 cartridge (Does not include student quantities for racing or quantities for testing.)
10 btls.	5 btls.	Tempera (water) paints, assorted colors, 2 oz. bottles
50 shts.	25 shts.	8 1/2″ x 11″ construction paper (assorted colors)
70′	14′	2″ x 4″ x 12″ wood
2 boxes	25	1/8″ I.D. x 5/32″ O.D. x 1 5/8″ paper-waxed soda straws
10 cans	5 cans	Spray paint (white)
500	100	1 5/8″ plastic wheels with 1/8″ axle hole
Start-Finish Gates and CO_2 Firing Accessories (Available from McKnight & McKnight Publishing Company)		
2	2	Unimax Precision Microswitch, MXT-2E-Z-362
2	2	Lamp base
2	2	Lamps
5	5	CO_2 cartridge firing mechanism with locking clips
100′	100′	40 lb. nylon monofilament
4	4	3/4″ screw eyes
250	50	Screw eyes 1/2″ long with 1/4″ dia. max. eye (diamond shape preferred)
2	2	3/4″ x 4″ x 36″ pine *or* plywood
1	1	3/4″ x 5″ x 12″ pine *or* plywood
1	1	3/4″ x 8″ x 12″ pine *or* plywood
1	1	3/4″ x 4″ x 12″ pine *or* plywood
Salt and Pepper Shakers, Assignments 38-55		
120	22	1 1/4″ x 1 1/4″ x 18″ woodstock
1 qt.	1 pt.	Paint thinner
1 gal.	1 pt.	Fast-dry clear varnish
10 cans	2 cans	Spray acrylic, clear finish
250	50	No. 4 corks

Supplies for Specific Products (cont.)

Per Teacher (5 classes)	Per Class (25 students)	Item
Conveyor System, Assignments 51-54		
5	1	70′ plastic webbing (approx. 3″ wide)
20	4	1/4″ x 6″ dia. plywood disk
2	2	4″ dia. qt. oil cans
10	2	2″ x 4″ x 10″ pine *or* fir
20	4	1″ dia. x 6″ dowel
5 rolls	1 roll	Friction tape
10	2	1/2″-20 x 12″ threaded steel rod
30	6	1/4″-20 hex nuts
50	10	Steel lock washers 1/4″ I.D.
4	4	2 1/2″ x 6″, 24-gage sheet metal
5	1	3/4″ x 7 1/2″ x 8′ to 10′ lumber (conveyor base)
Data Processing, Assignments 56-58		
375	75	Port-A-Punch cards (IBM D 10688)

Hero's Engine

Quantity Per Lab (5 classes)	Quantity Per Class (25 students)	
25	5	Coat hanger
25	5	Pipe cleaners
25	5	Epoxy resin and catalyst
25	5	#12 snap swivel (fishing tackle)
25	5	3/32″ O.D. aluminum *or* brass tubing, 2 1/2″ (model airplane gas line)
25	5	35mm. film can with lid
1 sht.	1/4 sht.	Emery cloth
50	10	3/8″ dowel, 2″

Product and Process R & D, Assignments 61-81

1. The teacher will need to set aside part of his budget (e.g., $1.00 per student) to be expended over these assignments.
2. The teacher, or the teacher and students, may select a simple product to be mass-produced within these assignments.
3. The program is scheduled so that there is about a 10-day period after a product has been selected and before which the materials are needed for production. Thus, the teacher should limit the selection of materials to those available locally on short notice.
4. Some thought should be given to utilizing any specialized equipment in the laboratory during these assignments.

Per Teacher (5 classes)	Per Class (25 students)	Item
Chemicals, Assignment 92B		
20 ml.	4 ml.	Sebacyl chloride (Eastman Kodak #6236)
500 ml.	100 ml.	Carbon tetrachloride azobenzene
200 gr.	40 gr.	Hexamethylene diamine (Eastman Kodak #P 5932)
5 pt.	1 pt.	50% aqueous alcohol *or* acetone
250 ml.	50 ml.	Tetrachloroethylene
20 gr.	4 gr.	Sodium carbonate

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
Screwdriver, Assignments 101-105			
2 pcs.	2 pcs.	Aluminum wire, soft, 1/8″ x 5/8″	
125 pcs.	25 pcs.	Drill rods, 3/16″ dia. x 6″	
125	25	Culture tubes, disposable glass, 20 x 150 mm. Available from hospital supply dealer.	
2 gals.	40 oz.	Clear case, liquid plastic with catalyst	95
1 btl.	1 btl.	Non-fracture additive, 4 oz.	95
7 tubes	7	Epoxy resin	
7 tubes	7	Epoxy hardener	
25	5	Cards, 3″ x 5″, or small plates	
25	5	Stirring sticks	
25 pcs.		Medium-grit silicon carbide abrasive paper, 3″ x 3″	
1 btl.	1 btl.	Quick-set promoter	95
I. D. Tag, Assignment 108			
25 pcs.	5 pcs.	20 ga. x 1″ x 5″ anodized aluminum (any color)	
125	25	Cotton swab sticks	
5 tubes	1 tube	1 1/2 oz. aluminum etching cream	
See General Supplies, Assign. 108		Contact vinyl	
House Marker			
125 pcs.	25 pcs.	Clear white pine, 3/4″ x 3 1/2″ x 12″	
See General Supplies, Assign. 108		Contact vinyl, dark color, 2 1/2″ x 8″	
See General Supplies, Assign. 110		Quick-drying aerosol spray enamel, 16 oz.	
Mallet, Assignments 97-99 and 119-124			
25	25	1″ dowel, 2″ long, pattern for mallet head	
25 pcs.	25 pcs.	Polyethylene tubing, 3/8″ dia. x 6″	
90 lbs.	18 lbs.	Type metal	
1/2 oz.	1/2 oz.	A Z flux	
1 btl.	1 btl.	Glue, white	
625 ft.	125 ft.	Sash cord, 1/8″	
3 rolls	3 rolls	Masking tape	
1 sht.	1 sht.	Abrasive paper, medium grit	
10 pcs.	10 pcs.	Dowel rod, 1/2″ x 36″	
1 can		Spray enamel	
1 qt.		Dip and grip rubberized vinyl	
1 box		Corrugated fastener 1/2″, No. 4	
17 ft.	40″	Threaded rod, 1/2″-20	
30 shts.	24 pcs.	4 1/2″ x 15 1/2″ abrasive paper, garnet paper, 80 grit	
17 ft.	40″	Tenite rod, 7/8″ dia.	
Utility Box, Assignments 126-132			
2 sq. ft.		Polyethylene, .060″ x 1/2″ x 5″	
65 shts.	13 shts.	Tin plate, 28 to 30 ga., 20″ x 28″ sheet	
125 ft.	25 ft.	Poplar, 1/2″ S2S, 4″ wide	
1000	200	Screws, sheet metal screws PH, No. 4 x 1/2″	

Supplies for Specific Products (cont.)

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
875	175	Pop rivets, steel, ⅛″ dia. x ⅛″	
125	25	Pop rivets, steel, ⅛″ dia. x ¼″	
250	50	Common nails, 10d	
125 pcs.	25 pcs.	Acrylic plastic, opaque, ¼″ x ¾″ x 6″, any color	
125 pcs.	25 pcs.	Acrylic plastic, clear, ¼″ x ¾″ x 6″	
1 btl.		Ethylene dichloride	
2 shts.		Aluminum oxide abrasive paper, 20 grit	
See General Supplies, Assign. 116		Silicon carbide, wet-dry abrasive paper, medium grit	

High-Intensity Desk Lamp, Assignments 142-176

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
See General Supplies, Assign. 8 - 9		Masking tape, ¾″ width	8 - 9
See General Supplies, Assign. 110		Stencil film, lacquer base	110
See General Supplies, Assign. 111		Silk screen paint	111
See General Supplies, Assign. 119-124		Dowel rod, ½″ x 36″	
900 ft.	180 ft.	#18-2 brown lamp cord	133
160	32	Brown snap-on electrical plugs	133
310	62	#72B wire nuts (small)	133
160	32	75 W, 250V sockets, base for high-intensity bulb	133
160	32	½″ x ⅜″ dia. nipples with hex nuts, steel	133
251 shts.	50 shts.	Chipboard (cardboard) .030 ga., 15″ x 22″	139
See General Supplies, Assign. 140		Duplicating paper	140
See General Supplies, Assign. 140		Spirit master	140
9 shts.		Postcard stock .010″, 28½″ x 28½″	146
50 shts.		Postcard stock .010″, 9″ x 12″	
3 shts.		¼″ plywood, masonite, *or* cardboard, 4′ x 8′ sheet for instruction panels (teacher-made)	145
160	32	6-A, 125V canopy switches (rotary single pole)	149
160	32	40 W, 120V bulbs, high intensity	149
160	32	½″ rubber grommets, ½″ I.D., ⅝″ O.D.	149
160	32	¼″ rubber grommets, ¼″ I.D., 13/32″ O.D.	149
160	32	Steel washers for #6-32 machine screws	149
700	150	⅛″ x ⅛″ pop rivets	149
160	32	#6-32 x ½″ FH machine screws with hex nuts	149
160	32	#6-32 x ¾″ RH machine screws with hex nuts	149
1000	200	#6 x ¼″ pan head sheet metal screws	149
150 ft.	30 ft.	Aluminum tubing, ½″ O.D., .049″ wall thickness, 10 ft. lengths	149
20 shts.	4 shts.	24″ x 22″, 26 ga. black iron	149
6 shts.	1¼ sht.	24″ x 96″, 20 ga. galvanized steel *or* black iron for base bottom	150
2½ sq. yd.	½ sq. yd.	Adhesive-backed felt	157
5 shts.	1 sht.	Medium-grit emergy cloth	157
5 rolls	1 roll	Embossing tape, optional	157

Supplies for Specific Products (cont.)

Per Teacher (5 classes)	Per Class (25 students)	Item	Assignment First Used
See General Supplies, Assign. 111		10—quick-drying aerosol spray enamel, 16 oz. brown paint	157
See General Supplies, Assign. 111		30—quick-drying aerosol spray enamel, 16 oz. white paint *or*	157
5 gals.	1 gal.	Fast-dry enamel	157
See General Supplies, Assign. 109		Contact vinyl, 18″ wide, wood grain *or* other pattern	157
See General Supplies, Assign. 111		Rubber cement	157
See General Supplies, Assign. 111		Rubber cement thinner	157
125 shts.	25 shts.	Construction paper, 5½″ x 8½″	169
30 shts.	6 shts.	Tracing paper	169
1 ball	1 ball	String for wrapping	169
1 box	1 box	Crayolas, assorted colors	169